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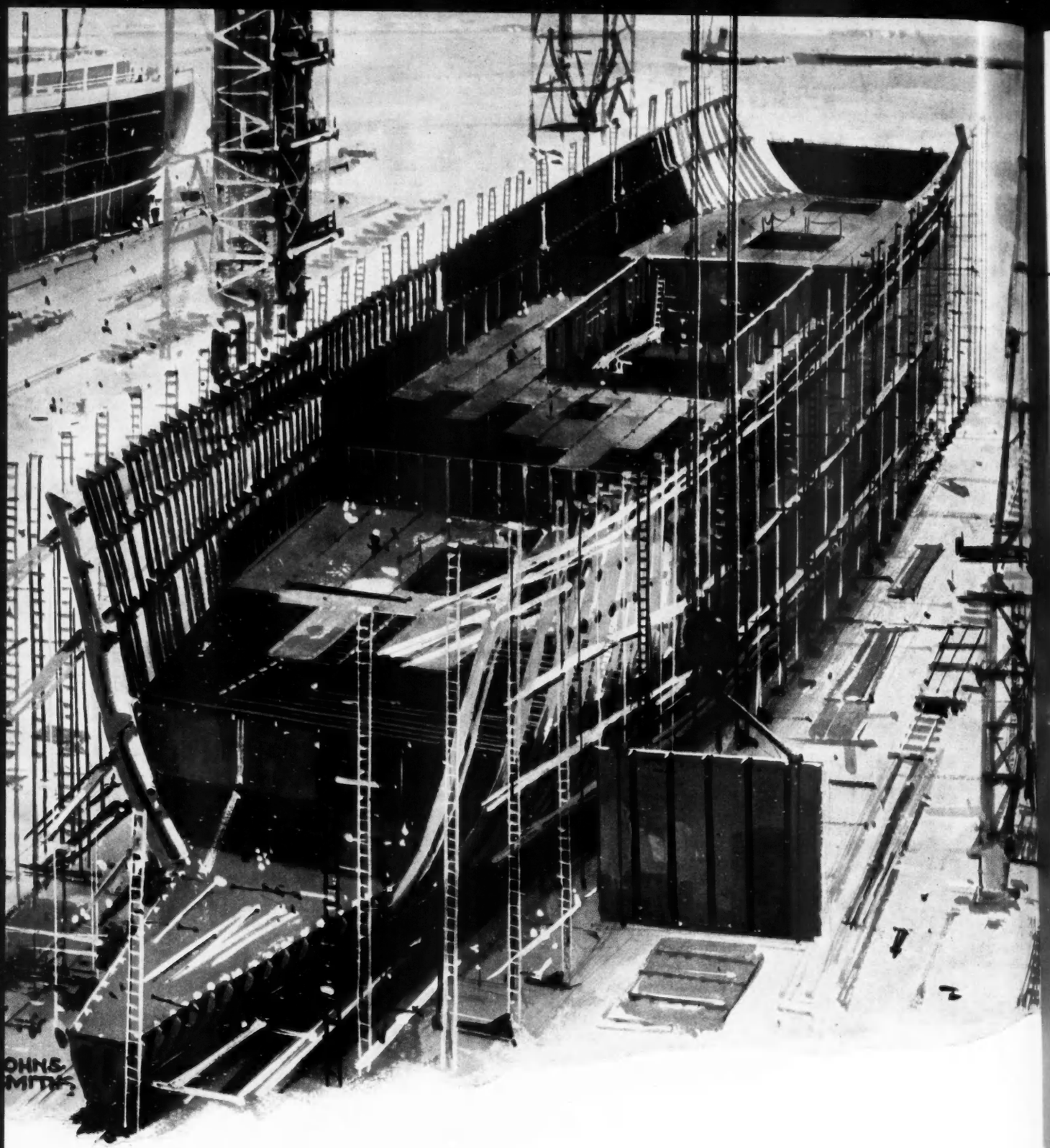

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Concentrated Thrust

To the accompaniment of further rockets and satellites and huge appropriations for science in the latest Russian budget, the British Department of Scientific and Industrial Research has announced its second five-year plan. The scale of United States and Russian efforts is a challenge to this country to undertake a limited programme of fundamental and applied research but to carry out that programme to a higher standard than can be done elsewhere. In colloquial terms it involves spotting winners. Throughout its history this country has shown a remarkable aptitude for concentrating on the right technical problems and even in recent years its work on the development of the jet engine and its lead in the application of nuclear energy to power production have demonstrated that this capacity to choose a number of priorities from a wilderness of alternative lines has not become impaired.

In the next five years, when the DSIR's new five-year plan will be in operation, this ability to choose the significant line of technical development and follow it through to commercial exploitation is likely to be tested as never before. There has been a great deal of argument on the amount of money spent on research by different countries. Whatever the precise figure may be, the two largest countries in the world are spending enormous sums on technical education and scientific development. In the Russian budget for 1959, expenditure on education is to be about £8,420 million, while scientific development is to have £2,500 million. It is worth pausing to reflect that these two together come to a sum well over half the size of the total national income of the United Kingdom, and that the total sum of money which the Government of this country can raise by taxation at the present time, even at existing penal rates, is only about £4,500 million. In the United States the latest estimate on defence for the year 1959-60 is £14,500 million, which is nearly three-quarters of the United Kingdom national income.

Even before the recent increase in expenditure on research and development by Russia and the United States, such figures as were available suggested that this country was lacking even on a proportionate basis. In 1955, according to figures given to the British Association in 1956 by Mr. Rudd of the DSIR, this country was spending about £300 million on research and development, which represented about 1·6 per cent of the gross national product compared with about 2 per cent for the United States at that time. So far as could be then ascertained the United Kingdom was spending about £5 million a year on fundamental research at the universities, another £5 million on Government and near-Government research, somewhere between £60 million and £100 million on civil applied research and about £200 million on defence research.

It would be quite wrong to write off the British figures as puny. If allowance is made for the lower internal purchasing power of the dollar compared with the pound, it is probable that the United States has been spending only about the same amount of money per head of population on research and development as this country.

It will be recalled that it was decided some years ago to adopt as an experiment the financing of the DSIR on a five-year basis. The Government has decided to repeat the experiment for a further five years, and over that time the DSIR's expenditure on research will be nearly doubled. Over the years 1959-64 approximately £61 million will be made available, compared with £36 million in the first five-year period. Expansion is to continue steadily up to an annual rate of £14 million in 1963-64. This figure will not include certain items, the largest of which is the British contribution to the European Organisation for Nuclear Research, which will be financed, as at present, outside the five-year plan. The biggest expansion is to take place in scientific grants to universities. Post-graduate awards to students are to be increased and special research in the research departments of universities is to be encouraged. To support additional research in its own laboratories, staff is to be increased at the rate of about 6 per cent per annum. Grants to the research associations will also be increased to over £2 million a year by the end of the period.

It has been decided to devote more attention and money to ensure that the results of scientific research are known and applied. The whole scheme is, therefore, planned on increasing the amount of fundamental research and making the results more readily available inside and outside the academic field. It has to be remembered in all this that a major shift has occurred in the direction of Government research and development away from the aircraft industry, and that its effort is, therefore, likely to become more diversified. The danger will be that the shift in direction will mean a movement away from a concrete line of development to nothing in particular.

Cover Picture.—*Among the equipment available in the engineering department of Cambridge University for demonstrating fluid flow to undergraduates is this vertical wind tunnel. The smoke used to indicate the streamlines is made by condensing paraffin vapour.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Far be it from me to tell anyone how to run his business, but I sometimes wonder what it must feel like to be sold in the market place. Mind you, I suppose it depends who's doing the buying, but on the whole I don't fancy myself with a placard round my neck marked " Lot 61." Yet that must be roughly how it feels to be employed by a company subject to a take-over bid. Last week the battle for control of a great British company took on a more complex and more acrimonious aspect. Emotions came to the surface and patriotism was thrown into the ring to jostle with self-interest. Another bid from a banking syndicate was made known to keep British control of the company.

While the owners and the would-be owners struggle for control it is worth remembering that the real sufferers in this kind of affray are the staff of the company. Nothing is more calculated to lower morale than the feeling that staff are being sold like cattle to the highest bidder and that some may even go to slaughter. It would be silly to denounce all take-over bids on this ground, for clearly it would be wrong to take the comfort of the staff as the criterion of efficiency. Such a view would be no more than condoning feather bedding of a more sophisticated type. But it is easy to forget that there are people concerned in these transactions who can do little or nothing to affect an issue in which they are deeply and personally involved. And that applies to all take-over bids.

Boards clearly have a double responsibility—one to shareholders and the other to the staff. To shareholders they are responsible for running the business efficiently and this includes consulting them when the shareholders' rights are involved and in paying out dividends which are a reasonable return on the shareholders' property. Dividends are not a treat handed out to well-behaved children. So far as staff is concerned, the board is responsible for keeping a business viable, flexible and making changes, even brusquely if conditions demand. It is not a kindness to shelter staff over the years, especially senior staff, from the economic facts of life. In other words, professional managements do not exist as an independent estate. They are there to be tough when toughness is necessary—for everybody's sake.

I'm hardly in a position to recognise the rights and wrongs of the present issue. It is sufficiently complicated for all to be right—and wrong. But it is important to remember that as the debate drags on, workpeople are becoming cynical and impatient. There may of course be others who relish their new importance, enjoying the rare pleasure of dancing in the limelight.

CAPRICORN

Weekly Survey

Quiet Flows the Nile

The winter of isolation which descended upon Egypt after the Suez affair is showing signs of thawing out. An agreement has been signed between the United Arab Republic and the Soviet Union on the building of the High Dam. The terms have not been published, but the official statement put out strongly suggests that it is not an exclusive arrangement. The total cost of Russian aid will be met by a long term loan of up to £36 million, to be repaid by supplying local commodities to Russia. It will be repaid in twelve annual instalments, beginning in 1964 and carrying interest at 2½ per cent. Most important, Russia is to be responsible for technical aspects of the project, but this is not thought to give the Russian engineers control over those parts of the work which are not done by the Russians themselves. In this connection an offer has been made by a private consortium in West Germany, according to reports which have not yet been confirmed. This consortium is said to be willing to invest up to £17 million in the High Dam project. The firms involved are Hochtief of Essen, Dortmunder Union Brückenbau of Dortmund and Siemens of Munich. Also Demag and Krupp may be involved as special contractors.

Meanwhile, there are signs of a rapprochement between this country and Egypt on outstanding financial problems. Both sides seem prepared to leave the question of reparations for war damage (raised by Egypt after the Suez campaign) on one side for the time being and try to settle other matters. The British are thought to have about £90 million of frozen Egyptian sterling balances in London, some of which Egypt would doubtless like to be able to draw upon in order to meet the first payment of compensation to the shareholders of the Suez Canal Company, which now falls due. The president of the World Bank has been invited by the British and Egyptian governments to use his good offices for promoting a settlement. It is not likely that Mr. Eugene Black would be asked to act in a personal capacity if each side did not think there was a reasonable chance of success.

Scotland's Power

Scottish Electricity: Plans for the Future, published last month by the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board, provides the background so far as Scotland is concerned, to the Electricity (Borrowing Powers) Bill. The latter proposed to raise the borrowing powers of the Electricity Council (covering England and Wales) from £1,400 million to £2,300 million; those of the North of Scotland Hydro-Electric Board from £200 million to £300 million and of the South of Scotland Electricity Board from £75 million to £135 million.

The generating capacity operated by the North of Scotland Hydro-Electric Board rose from the 230 MW taken over on nationalisation to 911 MW at the end of 1957, of which 729 MW was accounted for by hydro-electric stations. Between 1958 and 1964 inclusive, it is proposed to provide an additional 461 MW of hydro-electric capacity including 100 MW pumped storage at the Cruachan station. The Board is also planning the development of a 275 kV main transmission system similar to the supergrid in England.

The South of Scotland Electricity Board at the end of 1957 owned 19 generating stations with an output of 1,374 MW of which 122 MW represented hydro-electric capacity. The programme for plant under construction and projected by 1964 comprises an output capacity of 1,173 MW including the Chapelcross plutonium and power plant building for the United Kingdom Atomic Energy Authority. The programme also includes the Hunterston nuclear station on which work started in 1957 and which is expected to be commissioned in 1961 and 1962 with an output capacity of 300 MW. This station will operate at high load factor and will provide almost a quarter of the total electricity consumption in the South of Scotland. Work on a 275 kV main transmission system was approved late in 1957. This will include 5 new substations and 273 circuit miles of overhead lines connecting with England through the existing lines from Clyde's Mill, and most of the work is expected to be completed by 1963.

Ships in Port

The economics of sea transport are frequently argued by taking into account solely the economics of the various classes of vessel involved. That this gives only a partial picture was argued in a paper delivered by Mr. R. M. Thwaites to the North-East Coast Institution of Engineers and Shipbuilders earlier in this month.

The interdependence of ports and ships is very clear in those cases where they are both under unified control. For example, in the oil industry and in the production and distribution of iron ore Mr. Thwaites points out that there may be two geographically fixed points, the ore deposits and the known market, with the capital available for the project as a whole supplying a third and important fixed factor. With unified control one capital investment will be weighed against another so that the efficiency of the process as a whole will be as high as can be achieved. In a great part of the world's sea-borne trade, however, the inter-dependence is by no means so clear but is no less real. This dependence of the ship owner on port facilities available frequently tends, in Mr. Thwaite's opinion, to make the introduction of apparently obvious developments slow, since the mere introduction of faster and more efficient vessels will not necessarily mean that goods will enter and leave ports any faster.

The important factor raised in Mr. Thwaites' argument is that labour is the most important element in loading or discharging general cargo ships, and the cost of loading and discharging together has been found in a number of liner trades to be about one-third of the gross freight, and some 80 or 90 per cent of this cost has been found to be accounted for by labour. Conversely, lack of equipment is the least likely cause of congestion and delay.

Structure for Action

With the formation of the International Federation of Operational Research Societies, a study in which unity of subject matter is sometimes difficult to discern has achieved at least the beginnings of organisational unity. Operational (or as the Americans put it, operations) research has been described by Dr. Glen Camp as a science concerned with the structure of operations, where operations are defined as activities " in which a responsible authority utilises available human and material resources to accomplish a specified purpose, which latter may be hindered or aided by chance environmental factors." It is for the exchange of information falling within this category that the Federation has been created. Set up to further " the development of operational research as a unified science and its advancement in all nations of the world," IFORS came into being on 1 January.

To achieve its objects, IFORS is to sponsor

international conferences and meetings, to provide other means for the exchange of information on operational research between nations, to encourage the establishment of national operational research societies, to maintain standards of competence in operational research, to encourage the teaching of operational research, and to promote the development of specific parts of operational research, for example, to ensure a balance within that science or to open up new fields.

The foundation members of the Federation are the Operations Research Society of America, the Operational Research Society (United Kingdom), and the Société Française de Recherche Opérationnelle. Membership is open to other national societies whose primary object is the advancement of operational research and whose members include qualified scientists working in the field. One of the first activities of IFORS will be to sponsor the second international conference on operational research, following the successful first conference held in Oxford in 1957. The second conference is provisionally planned to take place in Aix-en-Provence in early September, 1960.

Announcing the formation of the Federation, Sir Charles Goodeve, who is its first secretary, said that, in addition to such problems as the handling of traffic or calls through a telephone switchboard, operational research workers were at present very interested in voting systems. Thus if the United Nations had adopted a system whereby the voting strength of each nation were some carefully chosen function of that country's population, then the difficulties created by the veto might never have arisen. The Federation will be governed by a board of representatives, one representative being elected by each society. The voting power of each representative is to be proportional to the square root of his society's membership, a formula designed to give the right weight to size. Sir Charles said that the American society had roughly 2,000 members, the British 500 and the French 300 ($44{\cdot}7^2$, $22{\cdot}4^2$, and $17{\cdot}3^2$). Initially therefore the issue is unlikely to be affected by the square root principle, but in future smaller societies will not be deterred from joining by a sense of impotence.

Mr. Donald Hicks is the first treasurer of the federation, which has its address initially at 11 Park Lane, London, W.1.

How Much Labour Where?

The debate in the House of Commons before Christmas on the employment situation started out with two tactical advantages for the Government. First, the Government had already said some time ago that unemployment would get worse through the winter before it got better and a level of 2·8 per cent unemployed has already been officially forecast for about February. This meant that there could be no element of surprise from the Opposition. Second, both the latest export figures and the unemployment figures have turned out better than anyone expected. The early December unemployment figures were definitely better than the recent trend. This may in the event prove to be very little of an improvement, but it was a valuable point for the debate.

The Opposition were able to draw attention to the high level of unemployment in Scotland, Northern Ireland and South Wales and there was a good deal of emotional appeal to the memories of the 1930's. They produced little in the way of constructive suggestions as to what should be done. The Government spokesman had earlier pointed out that the fall in the volume of exports some months back had already affected over 100,000 jobs and all the planning in the world will not produce export orders. Neither the present Government nor the Socialist one of 1945 to 1950 was able to do a great deal for the so-called " development areas " which still remain dependent on the heavy engineering industries. Both types of Government administration have offered special inducements for industry to move into these areas, but in an age of rapid technological change much must be done by private enterprise. The decision of the various interests on the Clyde to go ahead with the graving dock project and so improve the ship repairing facilities of Clydeside is worth pages of legislation and hours of debate.

Most people agree that the Government's policy of stimulating restocking, by lower interest rates and the end of controls on consumer goods, added to its stimulation of capital investment through local authorities and State industries, is the best prescription for the current recession. The timing of the exercise could go wrong it is true. The large amount of concealed unemployment created by companies hanging on to key labour although turnover has fallen may enable output to increase rapidly in the spring without a proportionate increase in employment—as has happened in the United States in coming out of its recession. This will affect the timing perhaps to a few months and may have some influence on the timing of the next general election, but nothing more could be done in the next few months to raise employment than has already been put in hand.

International Foot and Pound

Six standards laboratories have discussed the differences between the values assigned to the yard and the pound (avoirdupois) in different countries. To secure identical values for each of these units in precise measurements for science and engineering they have agreed to adopt international measurements having the following definitions. The international yard is to equal 0·9144 metre and the international lb to equal 0·453,592,37 kilogramme. It has been agreed that, unless otherwise required, all non-metric calibrations carried out by these laboratories on and after 1 July, 1959, will be made in terms of these international units. The laboratories concerned are the Applied Physics Division, National Research Council, Ottawa, Canada; the Dominion Physical Laboratory, Lower Hutt, New Zealand; the National Bureau of Standards, Washington, United States; the National Physical Laboratory, Teddington, United Kingdom; the National Physical Research Laboratory, Pretoria, South Africa, and the National Standards Laboratory, Sydney, Australia.

The new international units are in accord with the recommendations of the Board of Trade Departmental Committee on Weights and Measures Legislation but they will have no statutory force in the United Kingdom and may not be used for trade purposes in this country. The yard and the lb units used for trade are the imperial units laid down in the Weights and Measures Act, 1878.

As the imperial standard yard is about 5 parts per million (0·0002 in) less than the United States yard (which is defined in terms of the metre) and is shortening at the rate of over one-millionth of an inch per annum the significant discrepancies in measurement of length are important in precision engineering. Though the National Physical Laboratory, by using the metre and wavelengths of light and by adopting the 1922 value of the imperial standard yard in relation to the metre, has been able to stabilise its basis of reference for length measurements in terms of the yard, the unification of the yard standard for these purposes in the Commonwealth and in the United States has become a matter of urgency.

Steel in Fewer Hands

One of the provisions of the Treaty setting up the six member European Coal and Steel Community stated that amalgamations and concentrations could only be carried out with the approval of the High Authority. Any idea that this would freeze coal and steel production in its 1953 pattern is dispelled by the High Authority's sixth annual report.

No fewer than 27 concentrations of firms in the Community coal and steel industries have been approved since April, 1958. Only two of these are between firms in the coal industry, but seven concern cases where coal and steel concerns have been amalgamated. Most of these are in Germany where the steel giants, Mannesmann, Klockner-Werke, August Thyssen and Phoenix-Rheinrohr have all acquired coal mining interests. ARBED, the Luxembourg steel firm, has bought a majority holding in a German colliery.

The greatest number of amalgamations has taken place between steel manufacturers and processers; some of these cut across national boundaries. For example the Belgian steel firm La Providence has acquired a majority holding in the French Société des Tubes de Rebon et de l'Aisne. The well-known Pont a' Mousson enterprise has also bought up a tube making concern. Dortmund-Hörder-Hutten Union, itself the result of several mergers, has bought a controlling interest in the Howaldt shipyard at Hamburg. A similar move has been undertaken by Phoenix-Rheinrohr which has acquired the Blohm and Voss shipyard.

Mannesmann has been involved in several different forms of expansion. It has bought shares in the Porsch Motor Company and has acquired a controlling interest in a motor accessories firm with the engaging name of Mecano-Bundy Hans Sickinger GmbH. Mannesman has also obtained control of three mechanical engineering firms, two German and one French. All told, of the 27 mergers that have taken place, 21 have been of the vertical kind in which steel firms have bought interests in coal or iron ore, or in steel-using firms. The High Authority is reported to be worried about the amount of coal that now goes into " own consumption " in steel owned collieries. But while coal stocks remain at present levels no action is likely to be taken about this.

Letters to the Editor

REGENERATOR EFFICIENCY

SIR, In his letter to you published on page 819 in your issue of 26 December last, Dr. J. Spal comments on the part of my Presidential Address to Section G of the British Association, dealing with regenerator efficiency. Dr. Spal makes a number of points but the most significant from a practical point of view is his conclusion that the efficiency of a regenerator is " physically limited to the upper limit of 50 per cent " and that " any effort based on the supposition of higher efficiencies must lead to failure."

I am unable to accept this conclusion and indeed much higher efficiencies have been obtained; in their paper, in the *Proceedings* of the Institution of Mechanical Engineers, vol. 163, 1950, page 193, Cox and Stephens observed thermal efficiencies up to 93 per cent. I find difficulty in accepting many of the remarks in Dr. Spal's letter. Certainly the limiting assumptions he mentions do not apply to the theories of regenerators to which I was referring in my address and I am wondering whether Dr. Spal is familiar with the work of H. Hausen (*Z.A.M.M.*, vol. 9, 1929, page 173, and *Z.A.M.M.*, vol. 11, 1931, page 105), and the various writings of Dr. R. Ritz. He might also like to read the paper, " Heat Transfer in Regenerators," by Dr. Smoleniec and myself in the *Proceedings* of the " General Discussion on Heat Transfer," 1951, pp. 443-445, published by the Institution of Mechanical Engineers.

Yours truly,

O. A. SAUNDERS.

Department of Mechanical Engineering,
Imperial College of Science and Technology,
London, S.W.7.
5 January, 1959.

Special Articles

SOLAR SPUTNIK

Although the Russians can hardly have expected their rocket to enter orbit round the moon, it can be certain that this latest venture has contributed valuable data to the accumulating store of information on interplanetary space. Early this week, Academician A. Blagonravov, head of the technical science section of the Soviet Academy of Sciences, said: " The rocket will not become a satellite of the moon . . . it will pass by the moon and continue its flight into cosmic space within the solar system." Its nearest point of approach to the moon's surface was 4,660 miles—roughly a 2 per cent, or 1° 10′, directional error in the 240,000 miles interval between earth and moon, neglecting relative celestial motion. It was then expected to enter into solar orbit, so becoming the first artificial planet. Its nearest distance to the sun would be 91,500,000 miles on the 14 January, and its greatest 123,254,000 miles early in September. The plane of the orbit will be very nearly that of the earth, which is at a mean distance from the sun of 93 million miles and its period will be about 15 months.

The total weight of the missile at take-off may have been in the region of 200 tons, and its initial thrust of the order of 800,000 lb. The last stage, which is stated by Moscow to weigh 1,472 kg (something under 1·5 tons) without fuel, and to carry 361·3 kg (797 lb) of instruments, was designed to reach a speed of 11·2 km per second (25,200 m.p.h.). This is slightly more than escape velocity from the earth but considerably more than the maximum speed at which a missile could enter lunar orbit. Thus, unless it were fitted with an additional decelerating rocket to be fired at the appropriate moment—such as the " retro-rocket " devised by the Americans—the Soviet missile would be almost certain to leave the moon's gravitational influence.

Instruments are believed to include means of determining magnetic fields, radiation monitors and atmospheric recorders. Telemetry transmitters have been sending out radio signals on four frequencies. It is also reported from Moscow that a cloud of finely divided sodium would be emitted from the rocket; radiation would cause the cloud to glow so that it could be photographed from earth through spectroscopic filters. The photographs would provide information concerning the rocket's trajectory. It is said that such a cloud could also be used for reflecting radio transmissions. It is hoped that data on the moon's magnetic field, if any, may be made available, since this will help to indicate the moon's structure and history. Information concerning the sun's radiation, cosmic rays and any gas that may exist in interplanetary space is also anticipated. The real achievement lies in the accuracy of firing and the accumulation of data. The rocket was after all in orbit round the sun before it left the earth.

ROCKET THRUST

Last month the British Interplanetary Society heard a talk by Mr. E. T. B. Smith, of the Rocket Propulsion Establishment, Westcott, on rocket nozzles and exhaust jets. The speaker, first discussed the one-dimensional relation between the properties of propellent gases and the conditions in the combustion chamber, and the velocity with which the gas leaves the nozzle.

Mr. Smith noted that low molecular weight and high combustion temperatures were desirable to get high specific impulse. He then went on to describe the losses in performance which occur in most rocket nozzles, particularly losses due to the divergence of the nozzle exit cone and to wall friction. Since, for a given area ratio or design pressure ratio in a nozzle, a wide divergence angle results in a short nozzle, the losses due to divergence and friction vary with nozzle angle in opposite ways: for a particular nozzle throat diameter, if the friction factor were known, a divergence angle would exist at which the sum of the losses was a minimum. While, for small nozzles of heavy construction, the " standard " divergence semi-angle of 15° gave perhaps as good a compromise between performance and lightness as possible, larger motors, particularly those with lightweight construction and long burning times, should have nozzles of smaller semi-angle. On nozzle shape Mr. Smith said that, while specifically-curved profiles in the divergent parts of the nozzle could eliminate divergence losses, such profiles were very difficult to design.

Turning to the jets of gas produced by rocket motors, Mr. Smith showed a number of photographs which illustrated clearly the characteristic shock diamonds and the effects of mixing the air surrounding the jet and of burning the excess fuel at the jet surface. He described the mechanism of formation of these patterns, and also spoke about the " Mach disc," with a locally subsonic region immediately behind it, which can be formed when the outside pressure is much greater than the pressure at the end of the nozzle. The important subject, for builders of test stands and aircraft rocket installations, of the variation of pressure and temperature along a rocket jet, was discussed: for the example given (a liquid oxygen/kerosine engine working at 500 lb per sq. in with a nozzle 1 ft in diameter at the exit), a stagnation temperature of 1,000° C and a stagnation pressure of about 12 lb per sq. in gauge would occur 30 ft behind the nozzle.

The lecturer closed by saying that rocket engineers were ignorant about several aspects of nozzle performance: two of the more important were the behaviour of boundary layers in accelerating supersonic flow with very high temperature gradients, and the effects of chemical reactions occurring as the gases were cooled as they were expanded through a nozzle.

COMBUSTION OF PROPELLENTS

The problems encountered and some of the experimental techniques used in research on combustion in liquid-propellent rocket engines provided the subject of the British Interplanetary Society's January lecture, which was given by Mr. Dennis Carton, of the Royal College of Aeronautics. After covering the mechanisms of injection, spray formation and evaporation, chemical processes, and mixing and recirculation, and describing some of the ways in which unstable combustion could be promoted, Mr. Carton spoke about the work undertaken by the Rocketdyne Division of North American Aviation using two-dimensional (or " slice ") combustion chambers. These chambers are made (to judge by the photographs) as median sections of full-sized chambers of about 75,000 lb thrust, but the gap between the transparent sides (made of fused silica or acrylic resin) was only about $\frac{1}{4}$ in. Stills from cinematograph records, taken at 1,000 frames per sec, of a chamber with a shower-head type injector showed clearly a lateral motion of the flames caused by cyclical variations in the burning process close to the injector head. Another sequence taken during the ignition phase showed how combustion, apparently satisfactorily initiated, nevertheless intensified suddenly, one particular frame showing a luminosity many times greater than that of its predecessor: this typified the " hard start."

Mr. Carton also described some of the experimental work now being undertaken at Cranfield. He showed an elegant pressure transducer, on which most of the applied pressure was backed off by a steady nitrogen supply at accurately-known pressure, while the difference, small and fluctuating, between the chamber pressure and the reference pressure, was measured on a strain-gauge tube element. An accuracy of $\pm \frac{1}{2}$ per cent on full-scale pressure, with linear response up to 1,000 c/s, was claimed.

A qualitative investigation of combustion processes is being performed in a small HTP/kerosine motor by means of an " aerodynamic smear " technique. A plate of molybdenum is mounted longitudinally in the combustion chamber, across a diameter, so that it is exposed to a cross section of the flow in the chamber. A sprayed-on coating of " Rockide A_4," which consists of alumina with traces of ferrous and titanium oxides, is used to protect the plate and to record the velocity and temperature patterns by changes in coloration and by local fusing: striations in the glassy phase show the gas direction. As a development tool for rocket engineers this technique would seem to have a number of uses.

Mr. Carton's most impressive offering was a film, not previously available in this country, made by Dr. Typaldos of the Jet Propulsion Laboratory at Pasadena. This consisted of colour sequences, made at 1,000 frames per sec, of specially constructed combustion chambers about 4 in across. Both two-dimensional (slice) and axisymmetrical chambers were used, the walls being made of acrylic resin or fused silica. The propellents employed were generally red fuming nitric acid and ammonia. It was possible to distinguish clearly the way in which the propellent streams, particularly when shower-head injectors were used, persisted far down stream: even when a chamber 60 in long was used, a great deal of stratification was present up to the nozzle entrance.

With all injector systems, even those in which propellents were introduced uniformly over the width of the chamber, gas recirculation could be observed at the sides of the flame. Unsteady burning at the injector face was visible, but both this and the recirculation phenomena needed higher camera speeds to resolve them. Photographs taken with injectors giving pairs of impinging jets showed that the jet mixing process, even with accurately machined injectors, was not perfect: the jets often penetrated each other and separated, rather than giving a spray of mixed propellents. Much of the chamber appeared to be unoccupied by combustion when impinging-jet injectors were used.

New Year Honours

Included in the 1959 list of those upon whom the Queen has been pleased to confer New Honours were a number of engineers, scientists and executives, as well from industry generally as from the Services and Government departments.

A **Barony** in the peerage of the United Kingdom has been conferred upon SIR WILLIAM E. ROOTES, G.B.E., chairman of the Dollar Exports Council.

Knights Bachelor: MR. AUBREY F. BURKE, O.B.E., deputy chairman and managing director, of the de Havilland Aircraft Co., Ltd; Major-General CHARLES A. L. DUNPHIE, C.B., C.B.E., managing director, Vickers Ltd.; Mr. HUBERT HULL, C.B.E., President of the Transport Tribunal; Mr. JOHN W. LAING, C.B.E., President, John Laing and Son, Ltd.; Dr. REGINALD P. LINSTEAD, C.B.E., F.R.S., F.R.I.C., Rector, Imperial College of Science and Technology, University of London; Mr. JAMES A. MILNE, C.B.E., chairman and managing director of J. Samuel White and Co., Ltd., and President of the Shipbuilding Conference; Mr. EDWARD J. PODE, managing director, Steel Company of Wales, Ltd.; and Mr. KELVIN T. SPENCER, C.B.E., B.Sc., A.C.G.I., M.I.C.E., F.R.Ae.S., chief scientist to the Ministry of Power.

C.B.: Major-General L. H. HOWARD-JONES, C.B.E., REME; Dr. WILLIAM B. LITTLER, M.Sc., A.I.C., Director-General for Scientific Research (Munitions), Ministry of Supply; Colonel DONALD MCMILLAN, O.B.E., B.Sc., M.I.E.E., Director of External Telecommunications, General Post Office; and Acting Air Vice-Marshal GLYNN SILYN-ROBERTS, C.B.E., Director-General of Engineering to the Air Ministry.

C.M.G.: Mr. ROLAND C. COOKE, C.B.E., Director, Exhibitions Division, Central Office of Information, for services in connection with the British Government Pavilion at the Brussels International Exhibition; and Mr. CLIFFORD WAITE, chairman and joint managing director, Consolidated Tin Smelters Ltd.

K.B.E.: Mr. GEORGE W. H. GARDNER, C.B., C.B.E., M.I.Mech.E., F.R.Ae.S., Director of the Royal Aircraft Establishment, Farnborough; and Dr. MARCUS L. E. OLIPHANT, D.Sc., F.R.S., Director of the School of Research in Physical Sciences, National University, Canberra.

C.B.E.: Mr. STANLEY E. CLOTWORTHY, managing director, Northern Aluminium Co., Ltd.; Mr. THOMAS C. FINLAYSON, chairman, Woodall-Duckham Ltd.; Mr. PAUL T. FLETCHER, B.Sc.(Eng.), deputy managing director, Industrial Group, UKAEA; Mr. ROBERT A. LOVELL, O.B.E., A.M.I.Mech.E., chief mechanical engineer, Ministry of Transport and Civil Aviation; Mr. LESLIE T. MORTON, J.P., joint managing director, Clarke, Chapman and Co., Ltd.; Mr. JOHN A. RATCLIFFE, O.B.E., chairman, Radar and Signals Advisory Board, Ministry of Supply Scientific Advisory Council; Mr. JOHN H. REED, managing director, Ericsson Telephones Ltd.; Mr. REGINALD H. SCHLOTEL, F.R.Ae.S., Director, Engine Research and Development, Ministry of Supply; and Mr. JAMES MCW. STOREY, managing director, Dewrance and Co., Ltd.

O.B.E.: Mr. HAROLD ECCLES, M.B.E., A.M.I.C.E., H.M. Senior Engineering Inspector of Factories; and Mr. PETER W. MUMMERY, M.A., Head of Power Reactor Branch, United Kingdom Atomic Energy Authority.

Plant and Equipment

MESSAGE RECORDER

A device that will automatically record telephonic messages in the absence of an operator has obvious advantages for the one-man business. The Ansafone, made by Southern Instruments Limited, 49 St. James's Street, London, S.W.1, is such a device that has been developed over a period of four years and is now available through Keith Prowse and Company Limited and the British Home and Office Telephone Company Limited, the distributors. It has received approval from the GPO.

The Ansafone consists essentially of a tape recorder that is connected to the telephone circuit by a jack plug, and which also contains a short announcement message. When the telephone bell rings, a delay relay starts to operate and if the handset is not lifted within a matter of 10 or 15 seconds the device cuts in with the announcement. This usually consists of the subscriber's telephone number and name followed by the statement that it is the machine answering and will take a message. The recorder then starts. The tape has a run of 30 minutes, but if the caller does not speak for a period of 10 seconds or more the device assumes that the message is ended and cuts out, with another announcement to that effect. A window on the top of the case is illuminated to show that the Ansafone has been in use.

The Ansafone will record messages when the telephone is not answered by an operator.

As many messages can be recorded as there is length of tape available, but a protective device comes into operation if the amount remaining is not enough for three minutes recording. In that event the machine will not cut in and leaves the telephone unanswered. At all times it is possible to use the telephone in the normal way. Should the call be answered before the delay period is finished the recorder does not come into action, and at any point it can be stopped by a push button. It can also be started at any time to record messages even if the telephone has been answered in the normal way.

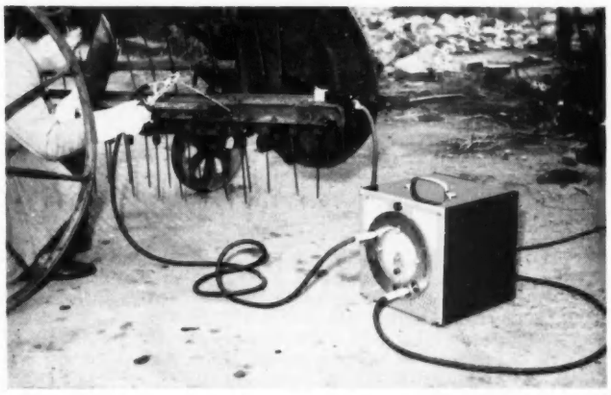
Recorded messages are played back by turning the control switch first to rewind and then to play. Either a speaker or headphones can be used, but the former is liable to some loss in quality. Both sides of a conversation will be recorded. The speech input circuit is 600 ohms at 800 c/s at levels between + 6 db and − 35 db relative to 1 volt. Cross talk below − 60 db on 1 volt will not be reproduced. Speech output for announcements is ¼ to ½ volt into 600 ohms and there is a 6 db recording bandwidth of 300 to 3,000 c/s. The machine is isolated from the telephone line by relays and a transformer.

The main control switch has a "pause" position intermediate between "play" and "rewind" which enables the user to stop the rewind at any point and also to hold the machine inactive to cover an interruption during the play-back. Only in the "normal" position is the Ansafone connected to the telephone line. Messages are usually erased automatically as the tape passes the recording head, but they can also be erased during rewind by using a hand switch.

The complete unit is contained in a case measuring 16 in by 12½ in by 8 in deep and weighing 33 lb. Standard models are designed for 200/250 volt 50 cycle supplies but others are available. Consumption is 100 W when operating and 33 W on standby. The Ansafone can be placed at any distance from the telephone instrument to which it is attached. The device can be purchased or rented, for which charge income tax relief is allowed.

PORTABLE ARC WELDING EQUIPMENT

A portable heavy duty industrial arc welder, the Fararc 200, which incorporates a toroidal transformer, has recently been introduced by Portable Welders Limited, Buckingham. This is almost certainly the first time that such a transformer with a single winding has been incorporated in British welding equipment and the performance is proving very satisfactory. The coil is air cooled and makes use of wire with high temperature insulation. The unit weighs only 70 lb and is contained in a cubic steel-case with a 14 in side. The windings are for 200/250 or 400/440 volts a.c. mains and provide an output of 60 to 200 amp for continuous use and up to a maximum of 230 amp for intermittent use. This is suitable for welding steel 1½ in thick and for cutting steel ½ in thick. The efficiency is high with a power factor of 0·82, so that no expensive power factor correction condenser is needed. Advantage has been taken of the low losses to make the difference between open-circuit and running voltage smaller than normal. Open-circuit voltage is in fact 50, which makes the unit very safe to use and reduces the magnitude of the striking current.



The Fararc 200 welding unit incorporates a toroidal transformer.

The necessary high ratio of flux density/ampere turns for this type of transformer has been obtained by using a cold rolled grain-orientated silicon-iron-alloy (generally referred to as grain orientated electrical steel) which also has a comparatively low wattage loss with high flux densities. The wire is insulated with glass, wrapped where necessary in glass-woven cloth, the whole being impregnated with silicone varnish and baked. The insulation will withstand temperatures up to 180° C without damage. Air cooling by means of a fan prevents excessive rise in temperature, but as an additional precaution a thermostatic switch is incorporated which, in the event of overheating, cuts off the welding current but leaves the fan running. The welding unit makes use of 14 to 4 s.w.g. welding rods. It is capable of being carried by one hand and has the power of conventional arc welding sets three or four times its size and weight. It should prove most useful for general metal or carbon arc welding in engineering industries where the emphasis is on use of equipment which is readily portable.

COLD STARTING

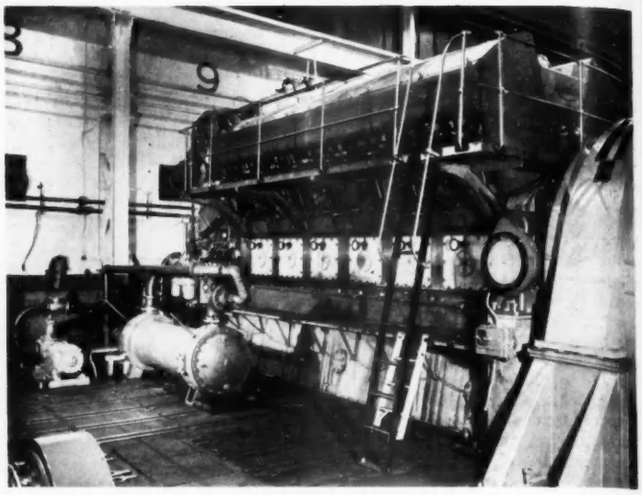
The MGA Polar Start primer for diesel engines which was introduced by MGA Industries Limited, 11 Forest Road, Loughton, Essex, last winter has undergone several modifications. The primer uses Caltex starting capsules and the capsule chamber is now fitted with a detachable base to facilitate cleaning. The T-handle is replaced by a moulded knob and the fluid is transferred to the manifold jets by nylon tubing. A range of jets is available to suit different manifolds. Another unit has been developed for use in extra cold temperatures and for engines of 10 litres or over.

Cold starting of diesel engines is assisted by injecting a highly volatile hydro-carbon.

Continuing **Plant and Equipment**

EVAPORATIVE COOLING

WHAT is believed to be the largest diesel engine installation using evaporative cooling has been built by Mirrlees, Bickerton and Day Limited, Hazel Grove, Stockport, for the United States Information Agency (Voice of America). The same firm installed a smaller plant in the power station of J. and T. M. Greaves of Belfast in 1955; full operating tests have been carried out there and heat balance sheets obtained; overall net efficiencies of 85 to 88 per cent are being attained. Some reference to this plant was made in our issue of 7 November last, page 610. The engine there is a six-cylinder KSS6 driving a 1,030 kW Brush alternator. The heat from both the cooling water and the exhaust gases is used for raising steam, space heating, and feed water heating for two Lancashire boilers.



Diesel engine installation, believed to be the largest yet made with evaporative cooling, for the Voice of America.

The new plant has two KVS12 turbo-charged engines rated at 2,724 h.p. each at 450 r.p.m., directly coupled to 1,750 kW Brush alternators. (These 12-cylinder V-engines have a bore and stroke of 15 in by 18 in respectively.) The cooling systems are pressurised to produce steam at 15 lb per sq. in so that the cooling water temperature will be 250° F. Only natural circulation is employed, the jacket water moving in a closed circuit. For about 20 minutes after the engine is started from cold there is no visible circulation (at the observation window); then vigorous movement suddenly becomes apparent. The reverse is true on shutting down. The steam is liberated in separators and is used to distil sea water and to heat the 3,500 sec oil on which the engines run. A completely separate circuit using sea water is used to cool the lubricating oil.

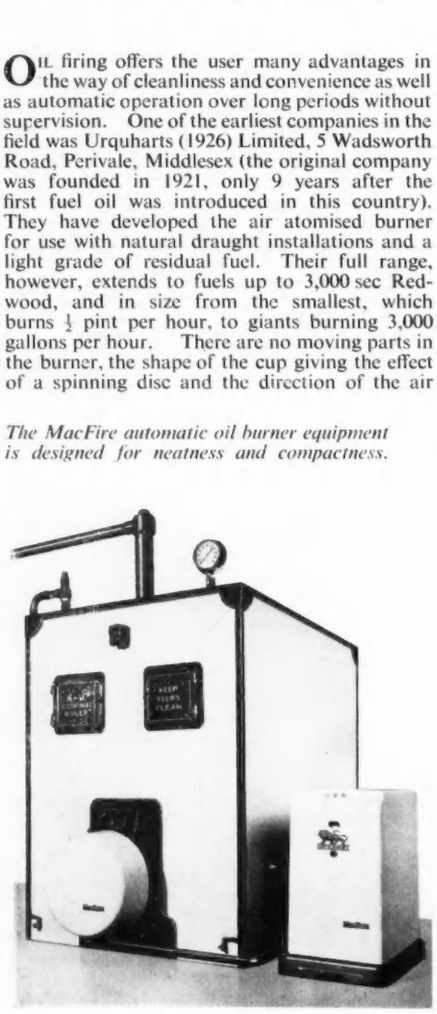
Each engine has a Westinghouse electro-mechanical governor giving speed regulation to ± 0·3 per cent at any constant speed over the full load range of the engine. The electrical part of the control measures generator frequency, generator load and fuel rack position and feeds the information to an amplifier. This in turn operates a hydro-mechanical actuator that adjusts the rack position to suit the load requirements.

There are three main advantages claimed for the use of evaporative cooling. These are: (1) regardless of load on the engine the jacket is maintained at a constant temperature; (2) by keeping the cylinder temperature high the exhaust gases do not fall below their dew point and the danger of corrosion by the deposition of sulphuric acid is eliminated; and (3) greater thermal advantage is obtained when using fuels in the region of 3,500 sec, as the steam produced can be used (as in this example) to heat the oil to the operating viscosity. Pressurising to 15 lb. per sq. in enables better conversion equipment to be used and reduces the size of the heat exchangers. Synthetic rubber rings have proved quite satisfactory for seals at this temperature.

OIL BURNERS

OIL firing offers the user many advantages in the way of cleanliness and convenience as well as automatic operation over long periods without supervision. One of the earliest companies in the field was Urquharts (1926) Limited, 5 Wadsworth Road, Perivale, Middlesex (the original company was founded in 1921, only 9 years after the first fuel oil was introduced in this country). They have developed the air atomised burner for use with natural draught installations and a light grade of residual fuel. Their full range, however, extends to fuels up to 3,000 sec Redwood, and in size from the smallest, which burns ½ pint per hour, to giants burning 3,000 gallons per hour. There are no moving parts in the burner, the shape of the cup giving the effect of a spinning disc and the direction of the air passages adding the swirl for very fine atomisation and good mixing. It is claimed that the surface mean drop size is 60 microns using an air pressure of 6 to 8 lb per sq. in. This drop size is only obtainable in pressure systems if they work in the 250 to 300 lb per sq. in range.

The MacFire automatic oil burner equipment is designed for neatness and compactness.



Combustion can be maintained from very weak mixtures to over-rich ones with the fuel at 2½ times the stoichiometric amount; these are used to produce a highly reducing combustible gas of about 120 Btu per cu. ft. In some cases the fuel control can give a 10 to 1 ratio even with a flame burning in the open air.

The most recent addition to the range of burners for heat outputs from 500,000 to 3,000,000 Btu per hour is the MacFire series, which are self contained and enclosed in glass fibre shields. A typical installation is shown in the illustration. In the box on the right are the control unit, the metering pump and the air compressor, while the cover on the boiler encloses the actual burner assembly. Apart from neatness of appearance the covers materially reduce the noise of operation to a very low and acceptable level. Natural draught is used.

The action of the unit is entirely automatic once the start button has been pressed. A yellow indicator light is illuminated to show that the operation has begun, but there is then a delay of three minutes to allow the combustion chamber of the boiler to become clear of any unburnt gas or oil vapour, which might be present following a false start. This delay is controlled by a Satchwell heat motor which at the end of the period makes contacts that energise the ignition transformer. A green light indicates that this stage has been reached and that the ignition sparks are being generated. After a further 5 seconds another set of contacts is made by the motor, which close the contactor to start the metering pump and the air compressor, both units being driven from the same motor. A diaphragm reservoir in the burner unit gives a delay of 3 to 4 seconds after the air has begun to flow before the oil reaches the nozzle when, if all is well, it should ignite. The ignition sparks are continued for a few seconds more to make sure of a proper light, and then the transformer is de-energised. Should there be no flame, a photoelectric cell detects the fact, shuts down the pump and compressor, and restarts the full cycle. Should there be a second failure the unit locks out and cannot be restarted until the relay has been reset by hand; a red warning light indicates this state of affairs.

The oil reservoir in the burner unit acts also as a preheater. In it is fitted an electric element that keeps the small quantity of oil hot when the boiler is not in use so that it is always ready for a quick start. On shut-down an air-operated diaphragm retracts as the air pressure falls and draws any remaining oil back from the nozzle and feed pipe into the reservoir so that there can be no drip from the burner. It is this quantity of oil that is kept hot. When the burner is alight the electric element (which consumes about 45 W) is switched off, and the oil is then heated from the flame through an alloy block which is exposed to the radiant heat of the flame, and conducts the heat back to a honeycomb block through which the incoming oil passes. This arrangement dispenses with the need for a line heater and thereby shows a considerable saving in electricity. An air pressure switch in the oil pipe cuts off the supply in the event of an air failure. The normal working air pressure is 8 lb per sq. in.

The metering pump works on the swashplate system and gives fuel control to an accuracy of 2 per cent at any pressure or suction required. In some units there is a hand adjustment to regulate the flow (by altering the angle of tilt of the swashplate) but an automatic control is also available if desired and the boiler can be fitted to operate on thermostatic control. The heat motor, the starting contactor and the flame failure relay are all mounted on a printed circuit panel making the wiring simple and compact. There are seven sizes in the series to give the range from 500,000 to 3,300,000 Btu per hour, using fuel with a normal viscosity up to 200 sec Redwood. The three largest are fitted with a two-stage start.

Companies in the News

City Support for Alcoa

The fight for the control of British Aluminium became more bitter last week when a group of 14 bankers and business houses announced their intention to spend at least £7 million to prevent control of the company passing to Tube Investments. The group, which includes such well established and respected firms as Robert Benson, Lonsdale, Hambros Bank, Lazard Brothers and Morgan Grenfell, made the reasons for this action abundantly clear in a letter to BA ordinary holders. It is based on the belief, stated with unusual strength and directness, that "the maintenance of British Aluminium as a separate British company in partnership with Alcoa is in the national interest and affords the best and indeed the only opportunity for investors to hold a direct interest in a British company engaged in the production, fabrication and sale of aluminium on an international scale."

This intervention may well tilt the balance against acceptance by the majority of shareholders of Sir Ivan Stedeford's offer, even if it is improved to match that of the bankers. They are known to have had consultations with the Bank of England and appear to be in a strong position. Already important holders who account for £2 million of BA's £9 million ordinary stock have told the group that they do not intend to accept the TI offer. One of the major holders, however, American Metal Climax, who own 7 per cent of BA's equity, emphasised that they were at present "neutral" and intended to remain so as long as possible.

The respective merits of each bid—Alcoa-City or TI-Reynolds—were discussed in recent issues of ENGINEERING (pages 727, 756 and 822, vol. 186, 1958, and page 3, 2 January, 1959). The balance of advantage seemed to tilt slightly in favour of Alcoa. Now leading personalities are involved and heads must fall if TI win. Last week end TI made a further move and increased their offer to one TI share and 88*s* each (against 78*s* previously) for every two BA shares; they also stated that shareholders who accepted the offer would be allowed to receive the 13½ per cent dividend proposed for 1958. Sir Ivan also admitted that TI and Reynolds Metals already own over £3 million of BA ordinary stock—about one-third of the total capital. (The figure has since been given as 40 per cent.) Sir Ivan also stated that 57 per cent would be kept in TI hands to maintain a British controlling interest. The whole business has become rather unsavoury and, it would seem, unwarrantedly so. The only gainers are the present holders, whose shares have risen in value from 37*s* before the fight began, to 84*s* 9*d* with every prospect of further increases. Over 1½ million have changed hands so far.

Expanding Bellows

Years of experience in the making of small metal bellows for use in aircraft pressure and temperature control instrumentation has recently been applied by Teddington Aircraft Controls Limited on a much larger scale—to expansion joints for hot gas and steam ducts in power stations, nuclear research plants and similar installations. For some years now they have been making stainless-steel bellows for turbojet exhaust ducting; about two years ago they decided to expand into the industrial field and they are now making circular-section bellows from stainless-steel sheet material, rolled and welded, capable of withstanding high pressures, in diameters up to 6 ft. A still more recent development is the rectangular-section stainless-steel bellows, fabricated from strip material rolled to a convoluted section, that they have been making during the latter half of 1958, in sizes up to 24 ft square.

The manufacture of both the large bellows for industrial applications and the small bronze or brass bellows, down to ⅜ in diameter, which are made solely for their own pressure-sensitive aircraft instruments, has so far been carried out in a small factory at Ammanford, Carmarthen. With a floor area of some 18,000 sq. ft, limited headroom and no overhead lifting equipment, Ammanford is not a convenient or efficient locale for the handling of the large components that are becoming an increasing part of Teddington's production. The company have, therefore, taken over from the Steel Company of Wales a derelict tin-plate mill at Pontardulais, near Swansea, and already a small section of the bellows production has been transferred from Ammanford, although much work requires to be done on the site before the whole works can be put into use. When completed in some 18 months time, Pontardulais will offer many advantages: a floor space of 78,000 sq. ft, its own railway sidings, a fine array of overhead gantries. Moreover, the occupation of the derelict factory will help to give employment to many of the tin-plate workers who have become redundant. The fact that the nature of the work will be completely different does not cause the company any worry; at their main Merthyr Tydfil works, where they have been since 1946, some hundreds of former coal miners took very readily to the making of the small high-precision parts used in the complex instrumentation for which Teddington are, at present, mainly known.

Among many recent and imminent installations of large bellows expansion joints by Teddington may be mentioned those for the Berkley and Hunterston nuclear power stations, and large rectangular bellows for installation in the flue ducts for boilers being supplied by John Brown Land Boilers at the new power stations being built at Kincardine, Staythorpe and Belvedere. Teddington also supplied the stainless-steel bellows torus for Zeta at Harwell. Incidentally, they are themselves moving into the nuclear instrumentation field, having recently formed an atomic energy division.

Hitched to a Wagon

The statements of the chairman of the two largest units in the British Motor industry, British Motor Corporation and Joseph Lucas, are useful commentaries on the vital role the motor vehicle industry is currently playing in propping up the economy. The mildness of the recession in Britain compared with that in the United States can almost entirely be explained by the record activity of British motor vehicle factories over the past twelve months. In North America the motor industry slumped and the economy followed; here it has done precisely the reverse. It is ironic that its high performance should have been due in a very large measure to the persistent demand of the American public for British cars. The industry's exports there—some 15 per cent of total output—made all the difference between boom and slump.

Sir Leonard Lord, chairman of BMC, told shareholders that output during the current year—August to December—had been "rather better than expected" and an improvement on the same period of last year. He had nothing to say on the next six months, although he clearly expects the home market to provide substantial support to offset the off-season in exports to the United States and the reduced purchasing power of Australasian markets. Overseas barriers are a major factor in the industry's future and he called for from the Government "less of the once-more-unto-the-breach-dear-friends attitude, and more support in trade negotiations with the countries concerned."

Mr. A. B. Waring, chairman of Lucas, was little more explicit on the prospects for the coming few months. Like Sir Leonard, he deplored the latest rise in engineering wages and pointed out that raw material prices were rising once again. The confidence in the industry's prospects which both Sir Leonard and Mr. Waring expressed was much affected by, if not based on, the recent restrictions on high purchase and credit controls. The behaviour of the home market may well be a decisive influence over the next few months.

Coseley's Private Boom

The remarkable progress made by Coseley Buildings Limited of Wolverhampton in recent years suggests that there is scope for new ideas in the construction field. Founded nine years ago, Coseley now have a turnover "of several million pounds" and continue to progress. Their speciality is "packaged buildings" for most purposes. They construct factories, warehouses, canteens, churches, army camps and clubs—which can be sheeted or finished in more traditional materials. The framework is invariably factory made "with the economic advantage of mass production." Buildings are sent in crates, complete with electrical wiring, plumbing and all services. Exports account for 75 per cent of total sales.

Coseley have recently added three new types of buildings to their range. One of these is designed to incorporate a crane bay, up to 10 tons in capacity, which is "permanent, flexible for future development and yet quickly and simply erected." A lifting beam is provided in the roof for the easy erection of the crane, together with compound gantry girders, predrilled to take downshop loads and complete with crane rails. A range of light frame buildings has been produced for countries where snow loading is not experienced. The third type is a range of sawtooth buildings, which provide diffused lighting, in bays of 62 ft 6 in span and 20 ft width.

Coseley are currently sending seven of their directors and three senior sales representatives overseas to visit some 30 countries. Their chairman, Mr. James N. Sinton, who has himself visited Persia, states his belief that "the world recession is coming to an end" and expressed his confidence that he and his colleagues will be "going in at exactly the right moment to bring in new business." Past performance suggests that they have been more often right than wrong.

Strike Orders

The decision of the Government to place orders for a new supersonic reconnaissance aircraft was discussed in Weekly Survey last week (Lucky Strike, page 2). The companies concerned have now been named. The aircraft which is to replace the Canberra in the 1960's is to be developed jointly by Vickers-Armstrongs (Aircraft) Ltd. and the English Electric Company (subject to further negotiations). The main contract is being placed with Vickers, but the work will be shared equally between the two companies and clearly English Electric, now building up considerable flight experience in the Mach 2 region on their P1B Lightning interceptor, will have a very considerable contribution to make. Also subject to satisfactory negotiations, the development of the engine for the new aircraft will be undertaken by Bristol-Siddeley Engines Limited.

The contract's arrival is timely. It will enable the companies concerned to keep their research and production teams together. Another result is a further tightening of ties between firms. A joint project team, drawn from both companies, is being formed by Vickers and English Electric. The Hawker Siddeley Group and the Bristol Aeroplane Company announced jointly their intention to merge the interests of their two engine companies into one single operating unit. These moves bring the Government one step nearer their objective, namely a concentrated and rationalised aircraft industry composed of large interconnected units with first-class research and development facilities and adequate resources.

The new RAF aircraft (project TSR 2) will be designed to operate from small airfields with rudimentary surfaces and have a very high performance at all levels. It is likely to be fitted with a derivative of the Bristol Olympus turbojet, which powers the Avro Vulcan bomber.

Management

WHAT THE FUTURE HOLDS *for* AIRCRAFT

The first article in this series appeared on page 6 of our issue of 2 January and dealt with the effects of exports, raw materials, and wages and working hours on industry as a whole. In the present article, forecasts of probable trends are given for three industries—aircraft; shipbuilding; and motor vehicles. Reports on other industries will be published in succeeding issues of ENGINEERING.

THE position of the aircraft industry does not grow any easier. From the time of the publication of the now famous Defence White Paper of 1957, it was clear that the industry, to survive, must greatly expand its civil production, and that the bulk of its markets must lie overseas. At that time, this country's exports of civil aircraft were doing increasingly well, though limited to the small and medium-capacity machines; competition on any appreciable scale being virtually confined to the United States. A great wave of aircraft buying was still in progress and air transport was expanding. It was apparent, however, that the market for aircraft for the main trunk routes had been substantially won by the American manufacturers offering large jet machines, but there remained a very considerable market for short and medium-range turbine aircraft in which a strong foothold had already been gained by British manufacturers.

On the face of it, the industry has done well. Exports in 1958 exceeded £155 million, and were thus nearly 50 per cent greater than the 1956 figure. There was redundancy, severe in some specific cases, but, overall, the level of employment dropped very little from its peak in January, 1957. Nevertheless, several factors combine to make this picture a somewhat false one.

In the first place, the decline in military production has barely had time as yet to take effect, except in isolated cases, but will make itself felt with increasing force during the coming year. In the second place, subcontracting and the manufacture of components by specialist companies plays such a large part in aircraft manufacture that employment statistics are always somewhat misleading, because the first impact of contraction in aircraft output falls on the subcontractors. Lastly, the past year's record level of exports represents the peak of the results of hard and successful selling of a generation of aircraft whose production will probably cease within the next year or two. Thus, in a short space of time, both buyers' sentiments and the competition to be faced have hardened appreciably. The position of the airlines themselves is more precarious than it has been for some years.

Traffic on the world's airlines had been increasing during the 1950's at a rate of between 14 and 15 per cent a year. Last year, however, this steady expansion appears to have come to an end and the rate of traffic growth has been only about half that percentage. While this slackening off has been attributed to the general recession, it is more probable that the first great post-war expansion of air travel was stimulated by the " expense account " traveller prepared to pay high fares for the sake of speed. Present indications are that this market has been thoroughly tapped and that future expansion will depend upon the progressive lowering of fares to put flying within the reach of a much wider travelling public. The success of " Economy Class " travel in the past year is strong evidence of this trend.

At this juncture, the industry's problems have become much more acute with the introduction of jet aircraft. During 1958, both British and American jet airliners were introduced on the North Atlantic route and, throughout the first few months of 1959, jet airliner operations will be widespread both in North America and in Europe. Airlines which remain committed to operating propeller-turbine aircraft for some years to come are naturally apprehensive that they may lose a large proportion of their passengers and this fear has given rise to the conflict over a surcharge on jet air transport, which is so far unresolved. The Cannes conference on fares, organised by the International Air Transport Association, failed to agree on this point, but it is meeting again early this year. A significant and rather ominous feature of the dispute is that the argument has reached inter-government level, in spite of the fact that the Association has so far been successful in keeping its discussions and agreements free from international politics.

The profit margin of airline operation has now reached a very low level, stated to be about 1 per cent for the financial year 1957-58, compared with about 3 per cent for the previous year. Insufficient appears to be known at present on the exact operating costs of large jet aircraft, but it is claimed that, in fact, they can justify lower fares than the aircraft they replace. There appears, therefore, to be at least some scope for argument on the relative economy of propeller-turbine machines as opposed to jet aircraft.

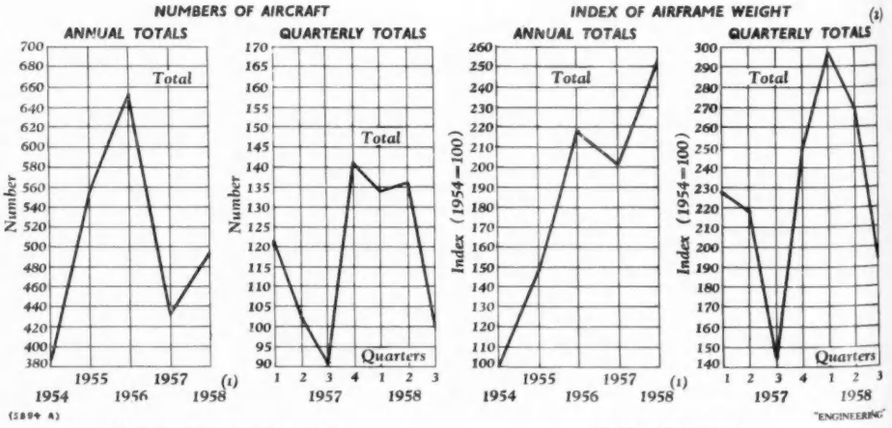
Evidence of the increasing difficulty of financing new aircraft purchases has been provided during the past year by two factors. In the first place, and for the first time in aviation history, an airline buying new transports has leased the engines from the manufacturers. In August, 1958, it was announced that American Airlines had ordered 25 Boeings and 25 Convairs with an option for 50 more. American Airlines announced that they were leasing the engines for both these types of aircraft and, moreover, that they had re-negotiated earlier orders for Lockheed Electras so that they could lease the propeller-turbine engines for those aircraft. It is likely that this trend will grow and while the leasing of aero-engines will undoubtedly make it easier for manufacturers to sell new aircraft it will also greatly increase the working capital required. In the second place, the British manufacturers have been placed in a position to offer the extended credit facilities which have for some time been offered by American manufacturers. The Export Credits Guarantee Department has been authorised by the Government to insure up to seven years' credit on large British airliners and civil aero-engines, instead of up to only five years as permitted hitherto.

It was stressed, when this extension was announced in the House of Commons, that the step taken was an exceptional one and that Britain was as unwilling as ever to start a credit race in regard to any particular export. Whatever the intentions, however, the increased credit facilities must represent a move towards increased governmental action in what has been hitherto principally a field for commercial transactions. Yet further evidence of the difficulty of financing new purchases is provided by the willingness of some American manufacturers to take back obsolete aircraft in part exchange for the new jet transports.

This whole situation leaves the British aircraft industry in a difficult position. During 1958, the industry reaped the rewards of hard selling and considerable foresight in design by increasing its exports to a figure probably over £155 million. Sales overseas of aircraft and parts rose from just below £70 million in 1957 to an estimated figure of over £100 million in 1958, while exports of engines rose to nearly £49 million. These figures probably represent the peak of the present expansion of British aircraft exports based on a generation of aircraft conceived as long ago as 1945.

What matters to the industry now and throughout the coming decade is the level of orders achieved for the aircraft now planned or at the beginning of their development life. Here, the outlook is by no means promising. The world's airlines have invested very heavily in the first generation of jet transports. In the past three years, they have spent over £1,000 million on new transports, both jet and propeller turbine, for delivery between now and the early 1960's. The great bulk of these orders have consisted

Deliveries of aircraft. The figures exclude military aircraft except those produced for export.



(1) Estimated on first nine months.

(2) Monthly Averages.

United Kingdom: Exports of Aircraft and Equipment (£1,000)

—	1956	1957	1958*
Aircraft and parts ..	71,769	69,767	100,575
Engines	28,001	40,642	48,756
Electric appliances ..	2,651	3,268	3,320
Tyres (outer covers)	688	814	555
Aeronautical instruments	1,429	1,979	1,911
	104,538	116,470	155,117

* Nine months annual rate.

of United States aircraft. By September, 1958, orders for American jet transports totalled at least £650 million, while a further £100 million was accounted for by announced orders for the Lockheed Electra turbo-prop. By contrast, orders for British turbo-jet transports stood at £126 million. The scramble to buy American transports has left many of the airlines in a very poor financial position and, to put it quite simply, the airlines probably have no more cash to invest in new aircraft over the next few years.

The heavy financial commitment of American airline companies in buying new aircraft has caused considerable anxiety in the United States. It has been estimated that the jet programme of the airlines in that country would involve outlays of some $2,600 million and that there was a shortage of some $760 million in the funds available. While the total mentioned has been reduced since the investigation was made it was nevertheless estimated, early in December, that Pan American, for example, was short by about $115 million. As has frequently been pointed out, the British aircraft industry largely depends at present on a very high export ratio, and, in the future, will increasingly so depend, since British airlines can provide only a small part of the required market for British airliners.

Orders for the Vickers Vanguard, whose first flight was expected before Christmas, still stand at 40; about half the figure required to break even. During the year, orders for 35 Vickers VC10's and 24 de Havilland 121's were placed by the British airways corporations. These orders, again, will go only part of the way towards covering the development costs of the aircraft concerned, which are all private ventures.

A further factor which deserves serious thought is the possible resale value of the big jet transports. Hitherto, in the expanding air transport field, it has always been possible for airlines operating trunk routes to sell off their obsolescent equipment to companies operating feeder routes, so that an aircraft starting its life on long-distance first-class transport had many years of useful life in front of it after being sold by the major airlines. The new generation of large transports, however, raises new problems. The runway requirements, apart from any other consideration, are so heavy that it is hard to imagine the Boeing 707, for example, being employed on routes on which the DC4 had been extensively used. In effect, these problems mean either that airlines will need to write off the large jet aircraft at a much more rapid rate than has been the practice up to now, or that their useful life on the world's trunk routes will need to be greatly prolonged. This necessity affects the prospects of British manufacturers to a considerable extent. Having missed the first wave of jet aircraft buying hopes have been pinned on providing a second generation of transports to replace them, in, say, six or seven years time. If, however, the present generation of jet aircraft is kept in service for a longer period than normally, there will be an awkward interval between the time when British airliners are ready for service and the airlines are ready to buy them. Indeed, it is conceivable that the transports now entering service may last until the end of the 1960's, when supersonic aircraft may be within reach.

The size of the aircraft industry has always been difficult to estimate owing to the large proportion of aircraft components subcontracted to organisations nominally outside the industry. The figure widely canvassed as the probable direct labour force of the industry in four to five years' time is 150,000, representing a considerable shrinkage from the peak employment of 266,600 in January, 1957. So far, nearly two years after the cuts in defence production and the switch to guided missiles were announced, the shrinkage has been small and the most recent employment figure (in September, 1958) has been given as 247,500. The existing high employment level is undoubtedly due, in part, to contracts for military aircraft which have not yet run out.

A further important factor which disguises the trend towards diminishing employment is the increasing effort being made by aircraft companies to diversify their production. In one case at least, that of the Hawker Siddeley Group, diversification has been largely achieved by purchasing interests outside the aircraft field. In others, however, companies have been diversifying within their own organisations, and examples which may be mentioned in this connection are the Fairey Aviation Company and Saunders-Roe. This trend will clearly continue. While, therefore, the employment on aircraft manufacture itself will undoubtedly decline, employment by the principal companies may remain more nearly at its present level.

On the redundancy question, however, much depends on the possibility of obtaining a limited number of new military contracts. A decision was reached last month that the OR 339 strike aircraft project was to be developed for the Royal Air Force and this OR 339 project, "subject to satisfactory negotiations," will be developed by a consortium consisting of Vickers Armstrongs (Aircraft) and the English Electric Company on the airframe, and the recently-formed Bristol-Siddeley Engines, who will provide the required jet engines. This decision carries a stage further the declared Government policy of encouraging the concentration of the industry into a smaller number of large groups. It will also keep together design teams which might otherwise have begun to drift to other industries. In addition the aircraft industry may hope for orders for a strategic freighter for the Services. The supersonic airliner development still continues at project level.

Failing new military orders, the industry now has a very heavy commitment for new civil projects whose future is rather problematical. Competition from foreign manufacturers is increasing. The Fokker Friendship has been steadily winning orders and the French Caravelle will enter service in Europe in the first months of the present year. Both these aircraft compete in a field in which British manufacturers were formerly predominant. Furthermore, this market will shortly be inundated with secondhand aircraft displaced by the new jets. Overall, therefore, the British aircraft industry is by no means "out of the wood."

One of the most significant trends of recent years has been the increasing interest in vertical take-off. This development has gone side by side with the development of large jet transports requiring ever longer and more massive runways. During 1958, the Fairey Rotodyne was successfully demonstrated and created a strong impression. A licence for its production in the United States has been granted, and early this month it was announced that provided the developed aircraft meets BEA's requirements, an initial order for six Rotodynes would be placed, to be followed possibly by an eventual requirement of up to twenty. Using a different approach, the Short SC1 has successfully maintained flight trials, and achieved vertical take-off and landing and transition to normal flight. Both these aircraft are undoubtedly pointers to the future, though, at the present time, that future seems rather remote.

One of the more ironical touches of the present situation is that Britain's success in the air in the post-war years has been largely due to pioneering work by British companies in the development of turbine engines. Though much of the initial lead has been lost, British engines are still in the front rank technically. The present decline in government support will, however, leave engine manufacturers in an increasingly difficult position. The development of a new turbine engine may well cost more than that of a comparable aircraft and could amount to as much as £15 million. Such a sum is clearly a very large one for an individual company to invest, especially with no certainty of aircraft being built to provide a market. The problems facing the aircraft industry remain, therefore, as severe as ever and there is no doubt that things will not be easy over the next five years.

What the Future Holds for SHIPBUILDING

1958 saw strong repercussions on the shipbuilding industry from the fall in freight rates, which has now continued virtually unbroken since the end of 1956. In the first nine months of 1958 Germany displaced the UK in launching the second largest tonnage in the world. In the nine months January to September, 1958, Japanese shipyards launched over 1·6 million gross tons. In terms of tonnage launched and at present under construction there are few signs of recession in the world's shipbuilding industry—in fact, total launchings during the first nine months of 1958 were some 800,000 tons higher than in the corresponding period of 1957, and tonnage under construction at the end of September nearly 900,000 tons greater. The real effect of the depression in shipping has been felt in declining order books, and here the position has become serious.

During the year ended September, 1958, new orders were received by British shipyards at a rate only half that of the previous year. The depressed state, both of the tanker and dry-cargo markets, led to a large volume of cancellations and, over this period, these cancellations would have exceeded new orders, had it not been for the inclusion of firm orders for several large tankers which were announced before the beginning of the period but for which the contracts had not been booked. Total cancellations during the period amounted to more than 400,000 gross tons, and in the year ended September, 1958, United Kingdom shipyards received net orders amounting to only two months' work at current levels of output. During the first half of 1958, cancellations of orders placed with shipyards in the United Kingdom amounted to 283,000 tons compared with new orders amounting to only 104,000 tons. Even so, the United Kingdom shipyards as a whole are in a fairly sound position, with an order book amounting to some six million tons, equivalent to about four years' output.

The German shipyards are estimated to have

Continuing What the Future Holds

orders of less than four million gross registered tons in hand as at the end of 1958, which is sufficient to keep them occupied only until the end of 1961, but, again, new orders are coming in, although very slowly. In contrast, the Japanese shipyards have shown a remarkable recovery since the middle of 1958. Orders on hand amount to about 3·4 million tons which, while appreciably lower than the level for the past two or three years, is better than had been expected. In the early summer of last year, it seemed doubtful whether Japan would achieve even 500,000 gross tons of new orders, which was the target set for the financial year 1958-59, and was only half the level of new orders achieved in the previous year. Since last April, however, more than 800,000 gross tons of new orders have been obtained, and it appears possible that as much as a million tons of new orders will have been received by April, 1959.

Both dry-cargo and tanker rates dropped sharply during 1957 and, in spite of some abortive signs of improvement, they have remained throughout the past year at levels but little above half those obtaining in 1952, the base year for these statistics. Nevertheless, there was a net increase in the world merchant fleet of some 7·8 million tons gross during the twelve months ended July, 1958, at which time the total tonnage amounted to 118 million gross tons. The total wastage during this period from casualties and scrapping was only one million tons, rather less than the average over the past few years. During the same period, there was an increase in tonnage laid up; the total in mid-June being about 8 million tons, some 7 per cent of the entire world fleet. There was a temporary revival in July, at the time of the revolution in Iraq, when some laid-up tankers were again put into use, but the general level of laid-up tonnage has remained high. In October, a total of 1·25 million gross tons of British shipping out of a total of about 20·3 million tons was lying idle, by the beginning of December this figure had been reduced to 958,000 gross tons. At the end of 1958, there was a slight recovery in tramp freight rates, largely due to seasonal demand for grain carriage, but this only had the effect of increasing freight rates to a level just below that at which it would be worthwhile putting laid-up elderly tonnage back into service.

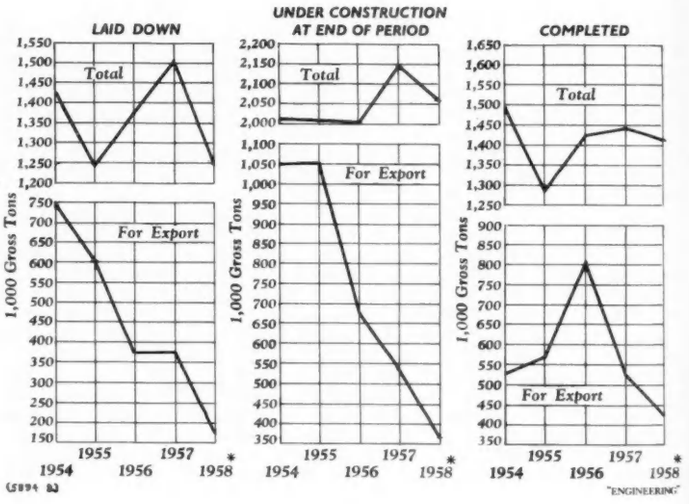
It is of interest to examine the breakdown of the total merchant fleet by age. Of the total of 118 million tons, 21 million tons were built before 1938 and are thus more than 20 years old, 50 million tons were built between 1938 and 1948, while 28 million tons out of the remaining 47 million tons are less than 5 years old. This analysis affords an interesting comparison with the average age of ships at present laid up. By far the highest proportion of the total consists of ships built between 1942 and 1946 (11 per cent of ships built in that period). The tonnage at present lying idle consists, therefore, to a marked extent of vessels which are either very elderly or of war-time construction, and in both cases largely uneconomic to operate. The question arises as to whether the present depression in freight rates will continue sufficiently long for these vessels finally to be scrapped. It has been suggested that if they should remain laid up much beyond the end of 1959 a large proportion will find their way to breakers' yards. So long as there remains a large tonnage waiting to be put into use the moment that freight rates rise, there is little hope of any improvement in the position of the shipowners. Clearly, the overall position of world shipping depends on when a marked recovery in world trade occurs. On optimistic estimates, such a recovery is unlikely to take place earlier than the autumn of 1959.

The general impression appears to be that by 1960 or 1961 there might once again be a shortage of tanker tonnage and this sentiment has already found expression in renewed orders for tankers for delivery at about that period. There appears to be little confidence that there will be an overall improvement in the situation before that time. This state of affairs has had a paradoxical effect on the placing of orders. The Japanese shipyards have built up their leading position largely by offering both cheap construction and, probably of more importance, rapid delivery. The latter gave them a decided advantage in the boom which followed the Suez crisis when a great shortage of tanker tonnage was foreseen in the near future. At that time, delivery dates offered by British shipyards were so far ahead that orders were naturally placed in Japan. The present situation, however, is that the larger shipyards in Japan, which have never suffered from any appreciable slackening of activity, can no longer offer appreciably quicker delivery dates than shipyards in Europe or America and, in fact, probably cannot deliver before 2½ to 3 years' time. This position brings the delivery date for orders placed now to about the time when many shipowners anticipate a revival in shipping. Accordingly, long delivery periods, which have been blamed for several years as an adverse factor affecting British shipyards, have now become a positive advantage. One of the anxieties of British shipyards during the past year has been the potential cancellation of ships for early delivery; this would lead to the necessity of persuading shipowners who had ordered for late delivery to accept an earlier delivery, which in many cases would mean merely accepting the vessel and immediately laying it up. On delivery dates, therefore, British shipyards are possibly better placed than they have been for some time, in comparison with their foreign rivals.

This situation, of course, applies mainly to the larger vessels. In each of the major shipbuilding countries, the bigger shipyards are in a very much better position than those equipped only for building small vessels, and, in some cases, the lesser shipyards will be virtually out of work within a few months if further orders are not received. Shipyards in Europe will be affected from this point of view much more severely than those in Japan, because the Japanese firms have faced a similar situation before in the post-war years, and have succeeded without too much difficulty in adapting themselves to production in other engineering fields, a process which is inherently more difficult in Europe.

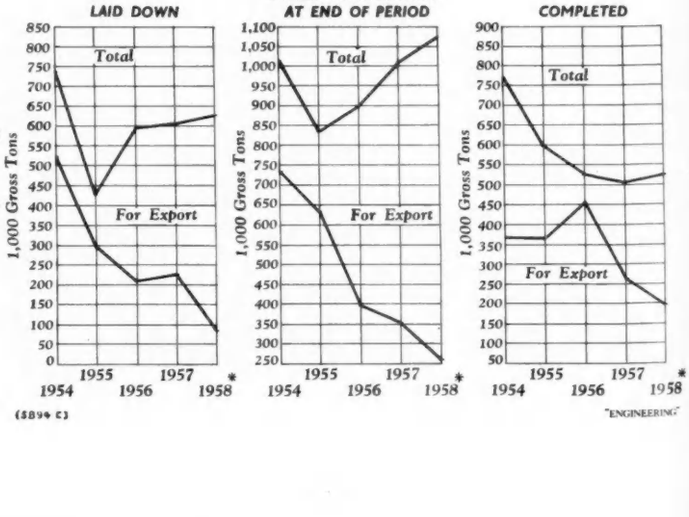
World Shipbuilding: Gross Tonnage Launched and Under Construction, 1958

—	Launched Jan. to Sept., 1958		Under construction 30 Sept., 1958	
	No.	Gross tons	No.	Gross tons
United Kingdom ..	205	1,003,123	328	2,299,133
Other Commonwealth countries	33	86,459	58	180,770
Belgium	14	113,064	16	172,637
Denmark	30	171,448	34	223,429
Finland	35	61,272	60	155,688
France	43	332,427	64	635,228
Germany	294	1,034,972	218	1,103,388
Italy	54	408,887	104	924,388
Japan	324	1,642,601	132	1,169,926
Netherlands	131	436,142	132	750,917
Norway	63	217,844	58	334,767
Spain	58	94,486	112	282,833
Sweden	58	526,451	63	594,781
United States ..	46	457,627	50	913,505
Other countries ..	89	229,366	134	474,395
Total	1,477	6,816,169	1,563	10,205,791



Merchant shipbuilding in the United Kingdom. (*Thousand gross tons*).

* *Estimated on first 10 months.*



Tanker construction in the United Kingdom. (*Thousand gross tons*).

* *Estimated on first 10 months.*

A further and much more serious question, however, is that of cost. At present, the Japanese shipyards, apart from now being able to offer delivery dates which suit the shipowners, have also benefited by marked reductions in Japanese steel prices. In 1956, steel plates in Japan cost, on the average, 61,500 yen (about £61·5) a ton (although, in some cases, buyers were willing to pay up to 100,000 yen (£100) a ton), while its price has now dropped to 48,500 yen (£48·5) a ton. The price, in 1956, of a supertanker of over 40,000 tons deadweight was quoted in Japan at about $270 per ton, whereas it has now fallen to the region of $150 to $160, and even to as low as $140, per ton. The Japanese shipbuilders maintain that, by cutting profit margins and taking advantage of the fall in steel prices, these levels are economic, though the Japanese Transportation Ministry have shown some alarm at what they feel may be pure price cutting. Their levels are, in fact, between 5 and 10 per cent lower than average world prices.

Perhaps the most attractive feature to shipowners is that the Japanese are still offering fixed prices and attractive deferred payment terms. Shipowners are growing increasingly critical, in an era of steadily rising wages and costs, of escalation clauses in shipbuilding contracts. Such clauses present a serious problem. For example, the Peninsular and Oriental company decided to enter the tanker field three years ago and the final cost of their programme will probably amount to £50 million, compared with an estimate of £37 million and in spite of a reduction of from 25 to 17 in the number of tankers to be built. The attraction of shipyards offering fixed prices at a time of low costs is obvious.

A further paradoxical feature of the present situation is that it should be a source of strength that, compared with Japan for example, the export ratio of British shipyards is low. Less than 20 per cent of the United Kingdom order book in mid-1958 was for export. It has been felt that British shipowners are less likely, on the whole, to cancel orders already placed than are foreign shipowners.

In the present situation, therefore, delivery dates are of far less importance than low cost and in this direction British shipyards still have a long way to go. It has been suggested, with some justification, that a country whose shipyards are claimed to be capable of building the best ships in the world could also build the cheapest ships if required. So far, however, there appears to be little sign that the extensive modernisation schemes put in hand by British shipyards are bearing much fruit. Some £50 million has been spent in recent years on modernisation and a further expenditure of £50 million is planned, but in too many cases the expected results are completely negatived by nagging demarcation disputes. The latest dispute in this series of absurdities concerned the use of a stud-welding gun at the shipyard of Cammell Laird and Company Limited. Efficiency in the shipyard has suffered for the past 12 years because of this dispute. As another example, the chairman of Alexander Stephen and Sons has said that so far his company, which has spent £1 million on modernisation, would have been better off if they had not spent a penny on the shipyards.

Overall, it is probable that new orders will continue to be hard to get during the coming year, though, by the end of the year, there may be the beginning of a recovery in world trade. This continued depression will affect the smaller shipyards much more severely than those capable of building larger vessels. The bigger shipyards in the United Kingdom have orders on hand which, provided they are not cancelled, will ensure employment for about four years. Beyond that point, unless there is a marked expansion in world trade, it is likely that there will be a surplus of shipbuilding capacity in the world. In such a situation, price considerations will become an even more important factor than they are at present. It is of the utmost importance, therefore, that such modernisation schemes as have been completed or are in hand should be fully utilised to reduce cost, and, moreover, that prices should be kept reasonably stable. If this cannot be achieved, it is likely, in spite of traditional ties, that even British shipowners may desert British shipyards in favour of their foreign rivals.

What the Future Holds for MOTOR VEHICLES

THROUGHOUT 1958, the motor-vehicle industry remained the most prosperous of the engineering group. Output during the year continued the recovery from the depression of 1956. For the first time, the production of cars in the United Kingdom is estimated to have exceeded one million. Although commercial vehicles experienced a slight decline in the export field, the total production of vehicles in this country rose from 1·15 million in 1957 to an estimated 1·37 million in 1958. During last year, the greater expansion of car sales took place in the home market; the production of commercial vehicles for the home market also showed a slight increase.

The overall export ratio for cars dropped from 53·7 per cent in 1957 to just below 50 per cent, and that for commercial vehicles dropped from 44·8 per cent to 39 per cent. There was some evidence in the third quarter that 1958 home sales of new cars had passed their peak, but it was at this point that the Government announced the freeing of hire purchase at the end of October. The result of this action has not yet become apparent; what evidence there is suggests that the hire-purchase sales of secondhand vehicles have increased to a marked extent, while hire purchase contracts on new vehicles have risen only slightly. The precise effect of the relaxation of credit restrictions will greatly affect the trends in the motor-vehicle industry during the coming twelve months.

The rapid recovery by the motor industry has been accompanied by an appreciable change in the export pattern. Up to a year or two ago, the most important markets for British motor vehicles were in the Southern Hemisphere—Australia, New Zealand and South Africa. The typical seasonal pattern of motor-vehicle sales has been smoothed out in the post-war period by two factors: in the first place, the demand for new cars in the United Kingdom has always been greater than the supply, so that prospective owners have been more liable to purchase at any time of the year than to restrict purchases to spring and early summer. The second factor, of course, is that the peak demand in the Southern Hemisphere occurs during the British winter.

This pattern now looks like being upset. The fall in world commodity prices has led to still further restrictions in the primary producing countries, while South Africa has found herself with an embarrassing surplus of unsold cars to add to her current balance-of-payment problems. By the middle of September 1958, it was estimated that about 25,000 new cars, valued at £16 million, remained unsold in factories and showrooms in South Africa. From the middle of 1958, there was a marked decline in new car purchases and further hire-purchase restrictions were introduced in September. The outlook for motor vehicles in South Africa was not at that time regarded as bright and the principal sufferer from any decline in new car sales will be the United Kingdom, the principal supplier of both C.K.D. (completely-knocked-down) and assembled vehicles. The 1958 figure for exports to South Africa, shown in the accompanying table, is based on the first three quarters of the year, and may, therefore, be an overestimate; in spite of an apparent increase in the past year, the future prospect appears less cheerful. Under the 1959 New Zealand import licensing schedule, the country will be importing roughly the same value of vehicles, but these will consist of a higher proportion of trucks and a lower proportion of cars. During 1958, imports from the United Kingdom were appreciably lower than in 1957, but British exports to Australia rose slightly.

The most striking feature of the year's exports has been the steady shift of emphasis to markets in the dollar area. Exports to Canada rose from £12½ million in 1957 to an estimated level of about £20 million in 1958, while those to the United States continued their steady advance, to reach a figure just short of £60 million. The total United States imports of cars rose spectacularly from 98,000 in 1956 to a figure that has been by some estimated as in the region of 375,000, in 1958. Sales in the United States of European cars are, of course, by no means confined to British manufacturers. Of the total of 206,700 foreign cars sold in the United States in 1957, 85,800 were German (including 64,200 Volkswagen), 29,200 French (of which Renault contributed 22,600) and 77,000 British. In

United Kingdom Exports of New Vehicles, Chassis and Parts (Value £1,000)

	Cars		Commercial vehicles		Total	
	1957	1958*	1957	1958*	1957	1958*
Australia	13,589	17,160	7,974	8,709	21,563	25,869
New Zealand	11,011	8,265	4,531	3,603	15,542	11,868
Canada	11,816	18,546	653	1,519	12,469	20,065
Union of South Africa	14,076	18,054	8,820	9,960	22,896	28,014
Rhodesia and Nyasaland	4,647	4,062	2,838	2,234	7,485	6,296
Ghana	853	645	2,292	1,592	3,145	2,237
Nigeria	1,653	1,570	3,114	3,355	4,767	4,925
Kenya	1,121	1,097	1,870	2,015	2,991	3,112
Singapore	2,226	1,952	1,381	1,273	3,607	3,225
Other Commonwealth countries	14,378	14,032	15,272	14,682	29,650	28,714
Irish Republic	3,576	5,203	1,212	2,207	4,788	7,410
Sweden	6,851	8,012	408	454	7,259	8,466
Denmark	3,153	2,723	2,341	2,678	5,494	5,401
Netherlands	2,921	3,412	2,088	1,414	5,009	4,826
Belgium	5,593	3,534	1,661	1,024	7,254	4,558
United States of America	39,588	59,665	255	—	39,843	59,665
Other foreign countries	21,009	23,406	28,488	26,561	49,497	49,967
Total	158,061	191,338	85,198	83,280	243,259	274,618
Parts	—	—	—	—	56,881	57,065
Grand total	158,061	191,338	85,198	83,280	300,140	331,683

* Figures for 1958 are based on the first nine months' annual rate.

Continuing What the Future Holds

November, 1958, Mr. Henry Ford predicted that the increase in purchases of European cars would continue and that the figure might reach 450,000 in 1959. While this state of affairs is very satisfactory from the British point of view, some doubts may well be felt as to the stability of the United States market.

There has been a growing discussion during the past year respecting the introduction of a small car produced by American manufacturers and there have been marked divergencies of view on the subject. The American domestic vehicle industry has suffered to a great extent from the recession. Motor-car production in 1958 is estimated to have been no higher than 4·75 million compared with over 6 million in 1957. Surprisingly, the set-back seems to have had no effect on the import of European cars, which appear to satisfy a quite different demand from that for those produced in Detroit: a position that is apparently accepted philosophically by the American producers. There was some speculation at one time as to whether United States manufacturers would introduce smaller cars towards the end of 1958; a course which might just have been possible assuming design studies to have been started when the first threat of European competition became apparent. In the event, the switch to smaller cars has not happened but it still seems likely that such cars might appear in 1960. The American public appears to remain as bemused by size and expense as ever and there is little doubt that an American "small car" would be a very different and much more expensive vehicle than its British counterpart. The president of General Motors stated during the year that only 10 per cent of Chevrolet buyers in the first half of the 1958-model year picked the cheapest six-cylinder model. Nearly 44 per cent of such buyers picked the highest-priced eight-cylinder models with a base price $400 higher, plus hundreds-of-dollars worth of extras. He said that it was necessary to offer an entirely new range of cars, different enough in mechanism and styling but certainly not cheaper than the present lowest-priced models. It is significant, also, that the lower-priced American cars have moved up the scale in size, luxury and price, and that the cheap car market is now served by a newcomer to the field, the American Motor Corporation, and by imported European vehicles.

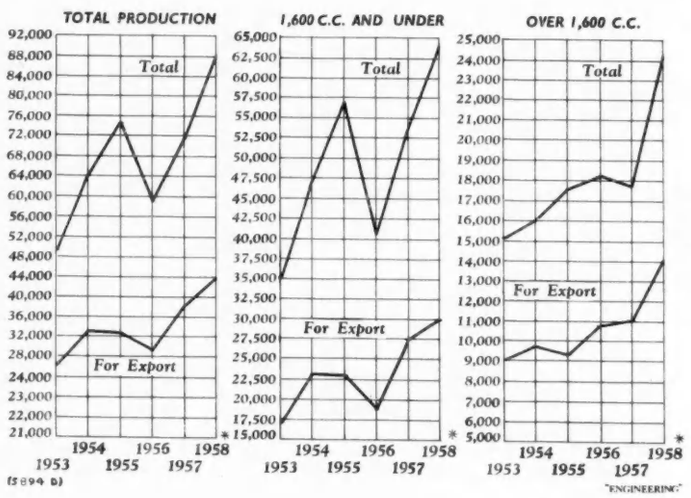
The contention is that European vehicles possess sufficient novelty and prestige value on their own to offset any feeling the American buyer may have of down-grading himself by buying a cheaper car. It has been pointed out in Detroit that there has already been an up-grading in the imported car field, with larger cars making up a substantial proportion of the 1958 imports. While some American spokesmen contend that the inroads made by foreign vehicles represent a threat to the domestic industry, others say that at current levels, representing about 8 per cent of the domestic production, they are no threat at all. Some feeling exists, too, that the boom in imported cars is slackening. There have also been suggestions that an appreciable part of the growing imports of small cars has been stimulated by the American manufacturers themselves, to enable them to assess market reactions to small cars without making production experiments themselves. Weight is given to this argument by the reflection that substantial quantities of Ford and Vauxhall cars are being imported. It looks, therefore, as if imports of European cars into the United States will continue to rise, but not at such a high rate as during the past two or three years. A great part of the success achieved in this period, by British manufacturers at least, has been due to an increasing awareness of the need for after-sales service; for which reason, such markets as have been achieved should remain fairly secure.

The United States has now become a net importer of motor vehicles; moreover, during 1958, the production of motor vehicles in the United States was running, for the first time, at a rate lower than that for the rest of the free world put together. This situation, though partly due to the American recession, is a symptom of the fact that American manufacturers have been expanding their production in those countries which formerly constituted their principal export markets (which are also, of course, low-cost producing areas). The trend will obviously continue and, therefore, the breakdown of the Free Trade Area negotiations may have a serious effect on the British position. With subsidiaries both inside and outside the European Common Market area, General Motors and Ford have to some extent a choice as to where further investment should be undertaken and it may well be that developing intra-European trade, following establishment of the Common Market, will appear to offer greater scope than further expenditure in the United Kingdom.

Exports to the Common Market countries have been accounting for a steadily diminishing proportion of total trade, and the Common Market will make trade with these countries more difficult. The three principal manufacturing countries in Europe, West Germany, France and Italy, together account for about 85 per cent of trade in motor vehicles between both the Common Market and the Free Trade Area countries. The share of European trade held by these three countries has been increasing during the past three years, while that of the United Kingdom has declined, by comparison, from 17·6 per cent to 11 per cent, in the Common Market, and from 16 per cent to 13 per cent, in the Free Trade Area.

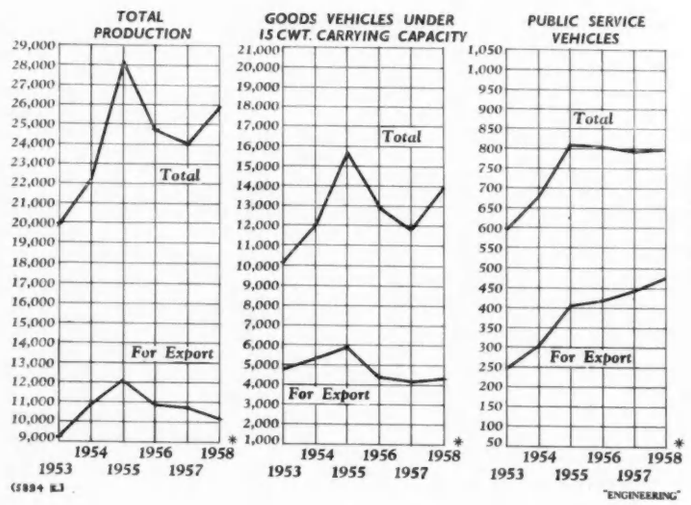
Advancing competition among European manufacturers has already become apparent. Italian manufacturers have paved the way by announcing price cuts and this action will undoubtedly lead to further cuts in the future. If the Common Market leads to economies of the scale which should theoretically be possible, the result will be not only to intensify competition in Europe, but also to increase the competitive power of European manufacturers in markets which are vital to the United Kingdom. It is notable that, of the three countries mentioned, the West German manufacturers are the most optimistic and hopeful of securing larger markets. Volkswagen estimate that their production will rise from 550,000 units in 1958 to as much as 750,000 units by 1960. The Volkswagen enjoys the largest sale in the United States of any imported vehicle.

In the short term view, therefore, the motor-vehicle industry seems likely to do well. It is probable that the Government's action in freeing motor vehicles from hire-purchase restrictions came just in time to stimulate the flagging home demand, and while markets in some Commonwealth and other countries may become more difficult, that in the United States will probably increase for the time being at any rate. Accordingly, rising demands seem likely to be able to absorb still further increased output for at least the next year. Beyond that time, the position is likely to become more difficult, unless a solution is found to the problems at present preventing the establishment of the Free Trade Area.



Production of passenger and chassis 1952-1958 (monthly average number).

Estimated on first 10 months.



Production of commercial vehicles and chassis 1952-1958 (monthly average numbers).

Estimated on first 10 months.

Automobile Engineering

MULTI-FUEL ENGINES

At the recent Salon de l'Automobile, the firm of Automobiles M. Berliet, Venissieux (Rhône) showed two new developments in their range of commercial vehicles. These were the " Magic " all-fuel engine and the " Relaxé " forward control cab.

The engine uses compression ignition to burn a very wide range of fuels. It is claimed that it will operate equally well on petrol or cod-liver oil; other fuels listed are paraffin, filtered raw petroleum from the North African wells, pea-nut oil and mineral oil. The 12 cylinder version used in the T100 is V-form with two exhaust turbochargers, one for each bank, giving an output of 600 h.p. At injection, 5 per cent of the fuel is directed to the centre of the combustion chamber and the remainder is directed tangentially to the walls, over which it spreads a thin film giving rise to progressive evaporation. The shape of the air inlet imparts a powerful swirl to the incoming air and gives good mixing. It is claimed, in particular, that these arrangements give increased power and torque with reduced fuel consumption, together with quiet running and good cold starting characteristics.

The T100 has a 600 h.p. engine that will run on crude petroleum or pea-nut oil.

The cab has been designed to reduce fatigue and improve comfort, and has a shell body instead of a panelled frame. It is mounted on rubber blocks, sound proofed and heat insulated, with the pedals in a water tight assembly. The steering column has a flexible coupling to prevent transmission of vibration to the driver. Noise is reduced with a corrugated canopy and an Isorel lining on the ceiling. Air conditioning provides a change of air, heated or cooled and filtered, every ten minutes, with adjustable temperature. The T100 has wheels 7 ft 9 in in diameter and is designed for a 90 ton load on its own, or for 125 tons with a special semi-trailer.

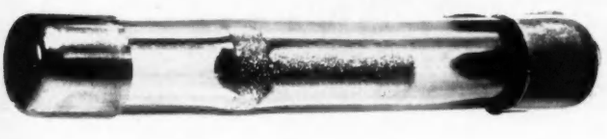
VISIBLE FUEL FILTER AND SHOCK ABSORBER

The Wipac Filter-Link, now being produced by Wico-Pacy Sales Corporation Limited, Bletchley, Buckinghamshire, is a combined visible fuel filter and shock absorber which can be quickly and easily fitted in the pipeline to the carburettor on almost any engine, from the smallest lawn mower to the biggest car.

The sintered bronze element comprises thousands of microspheres in contact, the flow of fuel taking place through the myriads of tiny channels between the spheres. This type of construction not only gives a high degree of surface filtration but provides also for filtration in depth. A physically small element can therefore do the work of more conventional types of much greater dimensions.

The Filter-Link is designed for use with ¼ in o.d. pipe which is now most commonly used; the element is supplied in a short length of plastics tube which is fitted simply by cutting the fuel pipe, removing any burrs and sliding on the Filter-Link so that the ends of the pipe enter the link about ½ in at each end. When fitted it becomes an effective shock absorber, relieving stresses in the pipe which sometimes cause leakage at the end fittings. Protection is given not only to the jets and small passageways in the carburettor but also to the needle valve and seating in the float chamber. It also provides a ready means of determining whether fuel is flowing from the pump. Cleaning can be carried out by removing the unit and blowing air through it in the reverse direction.

Normally, replacements of this Filter-Link are required only after about 10,000 miles of running have been achieved.



A sintered bronze element gives filtration and a visible indication of flow.

ELIMINATING TRAFFIC JAMS

A comprehensive exhibition of urban road schemes is being held in London, at the Institution of Civil Engineers, Great George Street, S.W.1, from 29 January to 7 February, under the auspices of the British Road Federation, in association with the Cement and Concrete Association and Shell-Mex and BP Limited.

Entitled " Town Roads for Today and Tomorrow," the display will indicate how countries all over the world are tackling traffic congestion in the towns, and is intended to show that the difficulties can be solved no matter how great or how small the town may be. There will be on show models, photographs and drawings of urban motorways, underpasses, viaducts, pedestrian subways and similar schemes from a variety of towns in Britain and throughout the world. These exhibits will illustrate schemes at the drawing board stage, under construction, and actually in use. A preview on 28 January will be attended by the Minister of Transport and Civil Aviation, Mr. Harold Watkinson. The exhibition will be open to the public.

BIGGER THREEWHEELER

The Mark F Bond Minicar (made by Sharp's Commercials Limited, Preston, Lancashire) has a larger engine than the earlier Mark D—250 cc as against 197 cc. With this engine the car can climb gradients of 1 in 4 with its full load of two adults and two children. The new engine is an air-cooled single-cylinder model made by Villiers, and has a bore and stroke of 66 mm and 72 mm respectively. With a compression ratio of 7·5 to 1 it develops 12 h.p. The four-speed gearbox can be fitted with an electric reverse if required.

The engine/steering assembly, which includes the unit-mounted gearbox, is carried on a subframe that is butt-jointed to the rear suspension members of the main chassis. The front wheel is carried on a single sprung trailing link beneath and behind the steering fork. Drive is by roller chain. The entire assembly can be turned through 180° from lock to lock, giving excellent manoeuvrability. The rear wheels are each carried on separate trailing links which are sprung through conical Flexitor bonded-rubber units. Maximum speed is 55 m.p.h. with cruising at 45/50. Fuel consumption is 70 m.p.g.

The new Minicar has a larger engine than the previous model and can climb gradients of 1 in 4 with two adults and two children.

Atomic Review

World Programme

A FURTHER four countries are discussed in the present series of articles considering national atomic energy programmes.

Greece

The Greek Nuclear Energy Commission is erecting an American-supplied experimental reactor near Athens for research and training, but there are no plans for power developments in the foreseeable future. The reactor is a 1 MW heterogeneous pool-type, manufactured by AMF Atomics. The fuel is fabricated by Babcock and Wilcox. The reactor will form the centre of research facilities including a hot laboratory, several laboratories for the physical sciences, and machine shops. Greek scientists and engineers are participating in training courses at the International School of Nuclear Science and Engineering at the Argonne National Laboratory.

Israel

A 1 MW heterogeneous pool-type research reactor made by AMF Atomics is expected to be completed at the Israeli Atomic Energy Commission Nuclear Centre near Rehovoth in the summer of 1959. The centre will contain a radiochemical laboratory for nuclear research and isotope separation, physics and electronics laboratories, and other services. Considerable progress in the nuclear field has been made at the Weizmann Institute, the Haifa Technion, and the Hebrew University. Israel is expected to have a power reactor by 1965.

Italy

Domestic mineral fuel resources are relatively insignificant, and the hydro-electric power potentialities of Northern Italy are fully exploited. These factors mean that nuclear power can play an important role in the further progress of the northern region and in the development of the hitherto under-industrialised south.

Resources

There are some uranium-bearing mineral deposits in various areas of the country, and work on prospecting and possible exploitation methods is being carried out. The industrial chemistry and metallurgy section of the Centro Nazionale per le Ricerche Nucleari di Ispra was set up at Milan in October, 1957, with the task, in addition to research in the field of extractive metallurgy for nuclear applications, of constructing a pilot plant for the production of uranium metal. This has been in operation with a capacity of 40 kg per day since March, 1958.

Research

The first Italian national laboratory for nuclear research is under construction at Ispra. When completed the centre will comprise the Ispra-1 heavy-water moderated and cooled research reactor using enriched fuel, together with a large number of laboratories. The reactor is of 5 MW thermal power, with flux levels of about 8×10^{13} thermal neutrons per sq. cm per sec and 11×10^{13} fast neutrons per sq. cm per sec. Fuel elements are of MTR type.

Plans

The Comitato Nazionale per le Ricerche Nucleari (CNRN) was set up in 1952 with general responsibilities for co-ordination of fundamental and applied research in the nuclear field, and with the approaching change of title, to Consiglio Nazionale Energia Nucleare, will now take over the regulation of research, the exploitation of material resources, and the production and utilisation of nuclear fuel and radioactive by-products.

Power Reactors

A number of power-reactor projects, divided broadly between British and American systems are proposed, and are listed in the table below.

Marine Propulsion

It has been reported in *Atomo e Industria* that Italy is considering construction of a nuclear powered cargo submarine in addition to a nuclear surface tanker projected by Fiat Ansaldo.

International Agreements

Bilateral agreements have been concluded between Italy and the United States for the supply of uranium for certain specified projects, and with the United Kingdom for the supply of reactors under contracts, for fuel, and for advice and training of Italian technicians. Italy is a signatory of the Euratom treaties.

Industrial Consortia

Societa Elettronucleare Nazionale (SENN), formed to acquire a nuclear power station with financial assistance from the World Bank (the ENSI project).

Agip Nucleare, a subsidiary of ENI.

Societa Italiana Meridionale per l'Energia Atomica (SIMEA), with 75 per cent Agip Nucleare capital.

Societa Ricerche Impianti Nucleari (SORIN), made up of Fiat and Montecatini.

Societa Elettronucleare Italiana (SELNI), in which the majority holding is Edison Volta.

TABLE.—*Power Reactor Projects in Italy*

Builder or operator	Electrical capacity	Reactor system	Fuel	Moderator	Coolant	Remarks
SELNI ..	135 MW	PWR	Enriched uranium	Light water	Light water	Agreement with Westinghouse
SoRIN ..	150 MW	—	Enriched uranium	—	—	—
	150 MW	—	Natural uranium	—	—	—
AGIP Nucleare ..	—	PWR	Enriched uranium	Light water	Light water	—
SIMEA (NPPC) ..	200 MW	Calder Hall type	Natural uranium	Graphite	Gas	Being built by the Nuclear Power Plant Company at Latina; due to start up in 1962
SENN.. ..	150 MW	BWR	Enriched uranium	Light water	Light water	To be built under Projetto ENSI promoted jointly by CNRN and the International Bank. Agreement signed with International General Electric

Japan

A combination of factors makes nuclear power of major importance to Japan: there are very small fossil fuel deposits; industries are developing at a very high rate; the population is increasing; and the standard of living is rising. Consequently the Japanese Atomic Energy Commission has evolved a long-term plan for the development of nuclear power.

Resources

There are several areas of uranium deposits, and further intensive prospecting is being carried out. Annual production is expected to reach 150 tons by 1965, but within the next two decades domestic supplies are not expected to meet more than some 6 per cent of demand.

Research

Four research reactors are included in the overall plan. These are as follow:

JRR-1, a boiling water type of 50 kW capacity, for use in basic researches, test production of short life radioisotopes, the training of engineers, and in gaining experience for work on JRR-3. Both JRR-1 and JRR-2 were supplied by the United States.

JRR-2, a CP-5 type reactor, intended for basic research, materials tests, and test production of radioisotopes.

JRR-3, to be the first Japanese made reactor, a natural-uranium, heavy water type, intended for research, engineering tests, radioisotope production, and for experience in design and construction. A materials and engineering test reactor is at planning stage.

Plans

The long-term plan mentioned above calls for a generating capacity of 600 MW from nuclear power by 1965 and 7,000 MW by 1975. At present the supply of a Calder Hall type reactor is still under discussion. Subsequently, a 10 to 15 MW enriched-uranium water cooled reactor may be built and then thermal and fast breeders each of 1 to 10 MW. It is hoped that a 100 MW breeder reactor may be designed and constructed using entirely Japanese manpower at some later stage.

Propulsion

Certain studies have been made by interested industrial groups on the application of nuclear power to ship propulsion, including that carried out for Osaka Shosen Kaisha Line, Mitsubishi and Ishikawajima, calling for a pressurised light water moderated and cooled thermal reactor of the PWR type with a thermal output of 180 MW.

Agreement

A bilateral agreement for co-operation in the civil uses of atomic power has been concluded with the United Kingdom.

Consortia

The Japan Atomic Electric Power Company is made up of private industry, the nine big power companies, and the Japanese Government.

A nuclear group based on the Tokyo Electric Express Railway has been proposed, with the object of importing a reactor, possibly from the General Dynamics Corporation.

Notes and News

UKAEA Inventions Available for Industrial Use

The United Kingdom Atomic Energy Authority, as a result of many inventions originating from the work of their research establishments, now hold a substantial number of patents and provisional patents in both the United Kingdom and overseas countries. Until recently the utilisation of these inventions had been mainly confined to the Authority. Now, however, many inventions are available for use in industry generally. Under an agreement between the Governments of the United Kingdom, the United States and Canada, several hundred American and Canadian atomic energy inventions have been assigned to the Authority. Many of these are also available for general use. These inventions, although originally developed for atomic energy purposes, also have general applications in the engineering, chemical, metallurgical, electronic and instrument fields; they can, therefore, be applied in a wide range of industries. One example of this is the Spraypak method of distillation evolved at Harwell which, although designed to assist in the production of heavy water, is applicable in other fields and licences have been granted for its used in the United Kingdom and elsewhere. When inventions are freely available, the Authority are willing to grant licences to suitable manufacturers in both the United Kingdom and overseas countries. Non-exclusive rights are normally given but in exceptional circumstances a sole licence may be granted.

It is customary for the Authority to provide, on request, sufficient technical know-how to enable the patent to be used. Where, however, considerable assistance is given an additional charge may be made.

Additions to the list will be made from time to time and brief descriptions of the latest inventions are also given in the Authority's monthly bulletin *Atom*. Inquiries should be addressed to: Patents Exploitation Officer, United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S.W.1.

Belgian Research Reactor

ICI (Belgium) SA, as agents for Marston Excelsior Limited, Wolverhampton, have obtained an order worth just over £100,000 for aluminium piping in connection with the experimental water-cooled reactor BR.2 now in course of erection at the nuclear research centre at Mol

in North Belgium for Centre d'Etudes de l'Energie Nucléaire. Both firms are subsidiaries of Imperial Chemical Industries. BR-2 is an advanced type of materials and engineering test reactor, using uranium enriched to 90 per cent uranium 235 as fuel with metallic beryllium as the moderator. At full output of 50 MW the epithermal flux will be $2{\cdot}4 \times 10^{15}$ neutrons per sq. cm per sec, and the thermal flux $6{\cdot}2 \times 10^{14}$. Criticality will be obtained with approximately 4 kg of fuel. Heat will not be recovered, but will be removed from the reactor by demineralised light water, which will be circulated at 2,270 cub. metres per hour. Marston Excelsior Limited are specialists in the fabrication of aluminium alloys and are experienced in this class of work for nuclear energy purposes. They will supply the pipes and fittings and carry out all the site welding at Mol, as well as supervising erection by the Belgian firm Fabricom.

Belgium Power Reactor

The 11·5 MW Westinghouse pressurised-water reactor BR-3 being built for the Centre d'Etudes de l'Energie Nucléaire (CEN) at Mol is scheduled to begin operation in 1960 and will provide power for north-east Belgium. Shipment of stainless-steel piping has begun. The prefabricated piping for the main coolant system has 12 and 16 in diameters and ranges in length from 9 to 14 ft. It carries the water under pressure of 2,000 lb per sq. in from the reactor at a temperature of 515° F and returns it to the reactor at 491°. The piping was manufactured for Westinghouse by Dravo Corporation, Pittsburgh, Pa. The reactor, made by Westinghouse and fuelled by uranium with a maximum enrichment of 4·43 per cent uranium 235, will have a thermal power output of 43 MW, and will produce 11·5 MW of electricity for feeding into the Belgian electrical system through the switching station at the Mol steam plant. Westinghouse is now running experiments on the reactor core at the company's Reactor Evaluation Center. Work on the foundation, containment vessel and turbine generator is well under way at Mol.

Faulty Reactor at Riso

Of 20 graphite reflector cells employed in a research reactor at the Danish Atomic Energy Commission's research centre at Riso, only four were found to be sound when tested recently.

Nuclear Chemical Plant

Nuclear Chemical Plant Limited of 22 Carlisle Place, London, S.W.1, the company formed jointly by the Power-Gas Corporation Limited, Humphreys and Glasgow Limited, and John Thompson Limited, for the design and engineering of process and treatment plant for nuclear industry, announce the appointment of Mr. R. W. Rutherford, joint deputy managing director of the Power-Gas Corporation Limited, as chairman and Mr. C. Gresle Farthing, deputy chairman and joint managing director of Humphreys and Glasgow Ltd., and Mr. J. H. N. Thompson, deputy chairman and joint managing director of John Thompson Limited, as directors.

Heavy Water Power Reactor Study

The USAEC has selected, as a basis for contract negotiation, the proposal of Sargent and Lundy, Chicago Illinois, for a design study of a heavy-water moderated nuclear power plant. A comparative evaluation of the technical feasibility and economics of various heavy-water moderated reactor concepts capable of using either natural or slightly enriched uranium as fuel will be made. Based on this evaluation, the plant concept and size will be determined, and a preliminary design and cost estimate for a prototype reactor power plant will be prepared. The Commission has indicated belief that a heavy-water moderated nuclear power plant is a type of reactor potentially capable of producing economic nuclear power. It has been determined that such a plant can best be developed by the continuation of developmental work conducted by E. I. du Pont de Nemours and Company since 1956, and by the performance of certain design work at Government expense. The proposed contract with Sargent and Lundy and the continuation of developmental work do not, however, imply commitment by the Commission to construct a heavy-water moderated nuclear power plant.

In connection with the Commission's study of heavy-water power reactors, the du Pont Company, operator of the Commission's Savannah River Plant, is undertaking the development, design and construction of a Heavy Water Components Test Reactor, to be located at the Savannah River Plant site. This reactor will serve primarily as a facility to test prototype fuel elements and other components intended for use in heavy-water power reactors. It is estimated that the test reactor will cost approximately $8,000,000.

Permit to Build but not Operate PRDC Breeder

The United States Atomic Energy Commission has issued an order, based on an opinion and initial decision, in the matter of Power Reactor Development Company of Detroit, Michigan, which affirms and amends a construction permit for a fast breeder power reactor issued to PRDC 4 August, 1956. The order continues the permit in effect with modifications and additions. The opinion and initial decision and the order are dated 10 December, 1958. The opinion stresses that " public safety is the first, last, and a permanent consideration in any decision on the issuance of a construction permit or a licence to operate as a nuclear facility," and notes that until questions relating to safety " have been answered to the satisfaction of the Commission, there will be no licence to operate the PRDC reactor".

Under a provisional construction permit issued by the Commission 4 August, 1956, the power Reactor Development Company, a non-profit membership corporation, is building a nuclear power plant near Monroe, Michigan, with a capacity of 100 MW of electrical power. The reactor is of the fast breeder type. The company has scheduled completion of the reactor facility by 15 December, 1960. Total cost of the project, including costs of test operation, is estimated to be $44,020,000. Steam generated by the reactor would be sold to the Detroit Edison Company, which would install conventional steam generating facilities at the plant site and would introduce the electric power generated into its regular power system.

On 31 August, 1956, three labour unions—United Automobile, Aircraft and Agricultural Implement Workers of America; United Paper Workers of America; and the International Union of Electrical, Radio and Machine Workers—petitioned to intervene in the proceeding, asked for a hearing, and requested that the Commission suspend the construction permit. On 6 October, 1956, the Commission directed the holding of a hearing. The request for suspension of the construction permit was denied without prejudice to ultimate determination by the Commission as to whether the permit should be continued, modified or vacated.

Elliott Nucleonics

Elliott-Automation Limited announced that Elliott Nucleonics Limited is to assume responsibility for the whole of the activities in the nuclear field of Elliott Brothers (London) Limited, Lewisham. Mr. G. C. Fairbanks, joint general manager of Elliott-Automation Limited, and a director of Elliott Brothers (London) Limited, Lewisham, and Mr. M. V. Needham, have been appointed directors of the company. Elliott Nucleonics interests initially will be those developed by Elliott Brothers (London) Limited, which centre around the control and instrumentation of nuclear reactors and power stations, and the associated chemical plants, and the uses of radioactive isotopes in industrial processes.

The products of the company will include the complete range of Elliott nuclear health instruments, of which the beta-gamma ground contamination monitoring recorder has been supplied in quantity to Harwell, and the recorders and data processing equipment for burst fuel element detection and reactor temperature monitoring, which are used in the nuclear power stations. It is intended that Elliott Nucleonics shall carry out the extensive instrumentation and control work being done by the group for the four nuclear power stations currently being built for the CEGB, and the design and manufacture of the control rod mechanisms for the advanced gas cooled reactor to be built at Windscale.

Colloidal Graphite

Colloidal graphite (marketed by Acheson Colloids Limited under the " dag " trade mark) has characteristics making it ideal for nuclear applications. It is said to have excellent lubricating and parting qualities; it is soft, non-abrasive, chemically inert, thermally and electrically conducting, and stable over a broad temperature range. It has proved to be an effective barrier material, providing both lubrication and protection where chemically incompatible metals are in sliding contact.

Product 459 in the dag range was used for protecting the interior surfaces of the pile chamber and cooling ducting during the construction of Calder Hall power and plutonium plant. The coating had to be easy to apply and resistant at temperatures of 400° C in a carbon dioxide atmosphere. There was an added advantage that the coating did not need to be removed before sealing the reactor. The heat exchangers being built by Head, Wrightson and Company for the Bradwell nuclear power station will be shotblasted and brushed with the same composition (nearly 3 cwt is required for the treatment of a surface area of 8,000 sq. ft) in order to provide protection in an atmosphere of contaminated carbon dioxide requiring the highest degree of internal surface cleanliness. The thermal sleeves are being smeared with another Acheson product, " Gredag graphited grease grade YK " as an anti-seizure measure. These details are given in the fifth number of the Acheson Colloids house journal *Prospects*.

Testing Graphite Blocks

A test rig incorporating the graphite blocks used in reactor construction has recently been completed by the Foster Instrument Company Limited, for the United Kingdom Atomic Energy Authority. Extensive research tests were carried out by the Foster Instrument Company's Experimental Department which included the measurement of temperature gradients in all planes through varying thicknesses of graphite, surface temperatures in the fuel element and isotope channels and time constants of various types of thermocouples. These tests were carried out under both static and dynamic conditions and under the latter, air flow rates of 37,000 to 87,000 cu. ft per hour were required necessitating the development of special types of contact thermocouples. The heat source was created from electric blanket heaters on all sides of the block assembly and special cartridge and V-formed heater elements mounted on dummy fuel cans.

By controlling air flow rates and temperature, operational conditions representative of any section throughout the entire depth of the reactor were simulated. The tests and the results obtained are considered to be an important step towards improved instrumentation of reactors.

Ford Award

Professor George Charles de Hevesy has won the Atoms for Peace Award, created as a memorial to Henry and Edsel Ford, for his discovery and development of tracer techniques in chemistry, biology and medicine, using natural and artificial radioactive and stable isotopes.

Enrico Fermi Award

Professor E. P. Wigner has received the third Enrico Fermi Award from the USAEC " for contributions to nuclear and theoretical physics to nuclear reactor development and to practical applications of atomic energy."

The Human Element

Extra Notice

A plan designed to give greater security to hourly-paid workers employed by Associated Electrical Industries was announced recently by Lord Chandos. The scheme covers all AEI's 65,000 wage-earners, who will receive greatly extended periods of notice in the event of redundancy. All hourly-paid workers who are over 18 and under 65 (or 60 in the case of women) and who have been employed by the company for at least three years will be entitled to one extra week's notice for every two years' service from the age of 18, in addition to the standard one week's notice. Thus a 22-year-old person who had been with the company for four years would qualify for three weeks, and a man with 20 years' service for 11 weeks. To assist those who are given notice in getting a job elsewhere, one day's leave of absence, during each week of extra notice, at normal rates of pay will be granted.

Lord Chandos emphasised that the scheme was not being introduced "to cushion the effects of an imminent redundancy campaign." Its purpose was to provide "additional security by the mere fact of its existence." Far from any redundancies being envisaged, new expansion plans were announced shortly afterwards which involve the doubling of the manufacturing capacity of AEI-Hotpoint Limited, who are the group's manufacturers of domestic appliances and one of the largest in the country. The project will create employment for some 800 people, 500 of them at Llandudno Junction in the washing machine factory and 300 at Peterborough where refrigerators are made.

The trade unions were informed about the new security scheme but not consulted. It is essentially a company measure and in no way affects the unions' scope for negotiation over the whole field of working conditions, wages and fringe benefits. Nonetheless, it is an example the engineering industry will find difficult to ignore.

Dockers Want Pensions

The dockers' section of the Transport and General Workers' Union have lodged a claim for a pension and a sick benefit scheme. The notification was contained in a letter signed by Mr. Tim O'Leary, the section's general secretary, which has just been received by the Association of Port Employers.

It is the third time that the dockers have asked for a pension scheme (some 8 per cent of registered men are over 65) but the first formal request for a sickness benefit. The employers' argument for refusing former requests for pensions was that their provision was a Government responsibility, and that both political parties were engaged in working out nation-wide pension plans.

The claim is expected to be discussed at a special meeting of the industry's national joint council, probably towards the end of the month. It would seem that the union is prepared to make a very determined stand this time.

Flying Column

The Solartron Electronic Group Limited are now widely known for the quality of their work. One of their ideas which has recently achieved some publicity is the creation of the Solartron Group Productivity Services. This is a specialised training and advisory service composed of organisation and methods engineers. It was brought into existence by a problem which is becoming increasingly common in branches of engineering where small groups of highly trained specialists are working, who need an efficient system of communication between each group to make cross-fertilisation possible (so that the left hand knows what the right hand is doing). At Solatron the entire organisation was expanding rapidly in manpower and in turnover; so the problem was developing quickly. When the organisation was small everyone could know what everyone else was doing. Later a specific piece of organisation had to be created to make this possible.

The problem was handled by the formation of this co-ordinating service, run by someone recruited for the job who had been an industrial consultant with a background as a plant engineer and acquired experience in work study. Incorporated in the new services is an organisation and methods department started some years ago.

As well as acting in a co-ordinating capacity, the service acts as what is called in the company a "commando force," which helps, especially on the administrative side, to set up new sections. It also has the job of forecasting the organisation and people required in 2, 5 and 10 years time, together with the demand for factory space and equipment. Altogether, it is a good example of a piece of basic thinking on what the problem for an organisation really is and what is the best way of solving it. It illustrates the good use which can be made of the scientific method in tackling management problems without imposing ready-made solutions taken out of the text-book with too little regard for local conditions.

Ganging Up On Change

Trouble is brewing at the Coventry car factory of the Standard Motor Company. The shop stewards in the assembly shop have told the management that they will not accept the imposition of changes in the gang system, pointing out that "existing pacts prevent the company from taking the action contemplated without the agreement of employees." The management want to centre work on a new car on an entirely new gang system, introducing smaller gangs. If the strike takes place, Standard warn, some 6,000 employees of Standard and of their suppliers will become redundant almost immediately. The human problems of change, with special reference to Standard have been discussed in an analysis by Professor Seymour Melman. The book *Decision Making and Productivity*, was considered in our leader "Sink or Swim Together" published last week.

Insight for Interviewers

It is generally accepted that an interview for the person being interviewed is something of an ordeal, something of a sales situation, something at which one improves with experience, and something requiring a systematic approach. The idea that practice and systematic training is just as significant for the person conducting the interview is rather less widely accepted. Yet this is an arguable idea and has been pressed for some time by a number of consultants, especially by Mr. Z. M. T. Tarkowski. Certain aspects of the latter's work, including the supervision of scientific personnel, were incorporated in the work of the Training and Education Division of the Treasury last year.

Interviewing is probably accepted as part of the psychological aspect of human relations and those who seek general management principles will be aware that systematic training in interviewing can be taught by case studies and by what is commonly called "role-playing." In brief, an interviewer so practised carries out a psychological analysis in a limited sense.

The basic criticism of this kind of approach is that if carried too far and multiplied up by all the other expert analyses which go to make the sum total of managerial analysis, the whole management function quite disappears in a welter of expertise from specialists. The factory unit becomes an army over-burdened by staff officers each with his own specialism. No one is left to lead and create *esprit de corps*. Good interviewing can surely be taught systematically but its use goes only so far. It is not a substitute for fair-mindedness, leadership and integrity. It is a tool, if a good one, and should be used as such.

Hot Seat

Nottingham University have announced that they have accepted a gift of £100,000 from Rolls-Royce Limited to endow a chair in thermodynamics. This is to be known as the Hives Chair and will be a permanent link between the name of Lord Hives and the university. Lord Hives is well known to industry as a former chairman of Rolls-Royce (he retired at 70 in 1957) and now as chairman of the National Council for Technological Awards. He has been closely connected with the university for many years and is at present the treasurer and a member of the court.

This is one more example of well-known companies making a direct contribution to widen the basis of technological education in this country. For those who believe in the importance of independence, in some degree, for educational institutions this trend is very welcome. At the present time, it is apparent that a big expansion in technical training of all kinds is developing and that it will have to be paid for either by industry directly or through the State by taxation. In these days some direction from the State in educational matters is essential but a degree of independence is equally desirable. Gifts and grants by industry are one of the few ways left of providing a modicum of that independence.

It is to be hoped that a growing number of companies in the economy will see the problem and the opportunity this way. The large concerns as a whole have given an excellent lead over the last few years. It is now up to smaller ones to follow suit. If few can afford to give on the scale of the big concerns the idea of the consortium is a flexible one that may be worth examining in certain circumstances. It is already at work in the electrical power industry with some success.

Liverish After Christmas

An interesting problem of human relations came to light when some 1,100 maintenance workers went on strike at the Port Talbot, Margam and Abbey Works of the Steel Company of Wales. The men are members of the Amalgamated Engineering Union, whose official attitude is severely critical of the management's action in suspending several men who failed to report for duty during the Christmas holiday.

The management's action would appear to be wholly warranted and in line with existing agreements, though not perhaps in accord with the Christmas spirit. The men, they say, failed the company by not being available "to carry out essential duties in accordance with an existing trade-union agreement." It must be galling indeed for the management on duty to find that men chose to remain by their fireside instead of helping to keep the steelworks going, and also to those maintenance men who turned up and had to work harder to make up for their comrades' absence. Nonetheless, there was immediate strike action, called off only when the union officials took over.

Strike notices have now been served by the AEU in accordance with their agreements. Meanwhile, a settlement will probably be negotiated. A clear case of bad temper in the wrong season.

Design

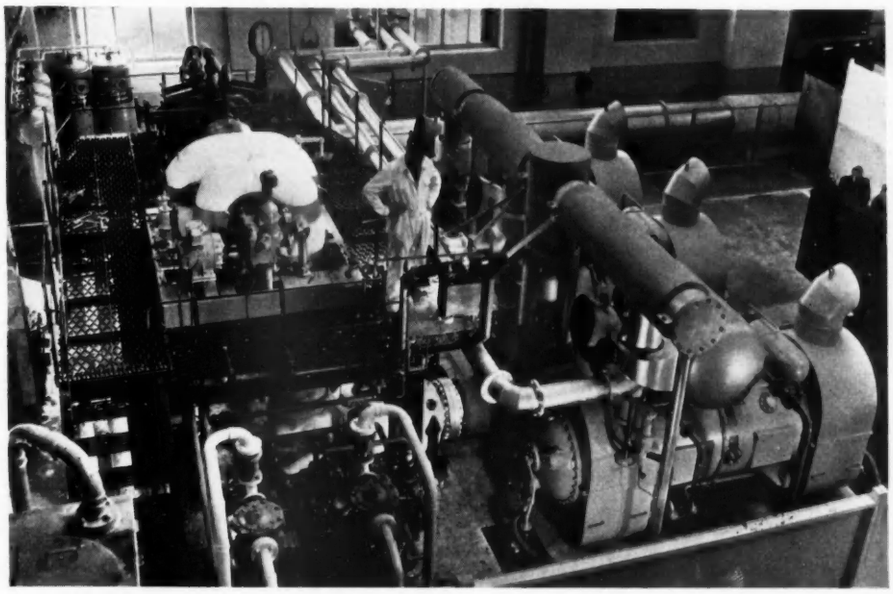
GASIFIER-TURBINE PLANT DRIVES A COMPRESSOR

Construction and Control System

An installation in which free piston gasifiers were used to drive a turbine was recently demonstrated by the National Gas and Oil Engine Company Limited, Ashton-under-Lyne, Lancashire. The system had been used for tests on equipment ordered by Kellogg International Corporation to drive compressors at an ICI chemical plant at Wilton. For the ICI installation six gas turbines are required to operate in conjunction with free piston gasifiers, each of the turbines being individually controlled by a throttle valve operated either by a constant speed governor driven off the main shaft, or in response to an air signal derived from the turbine-driven compressor.

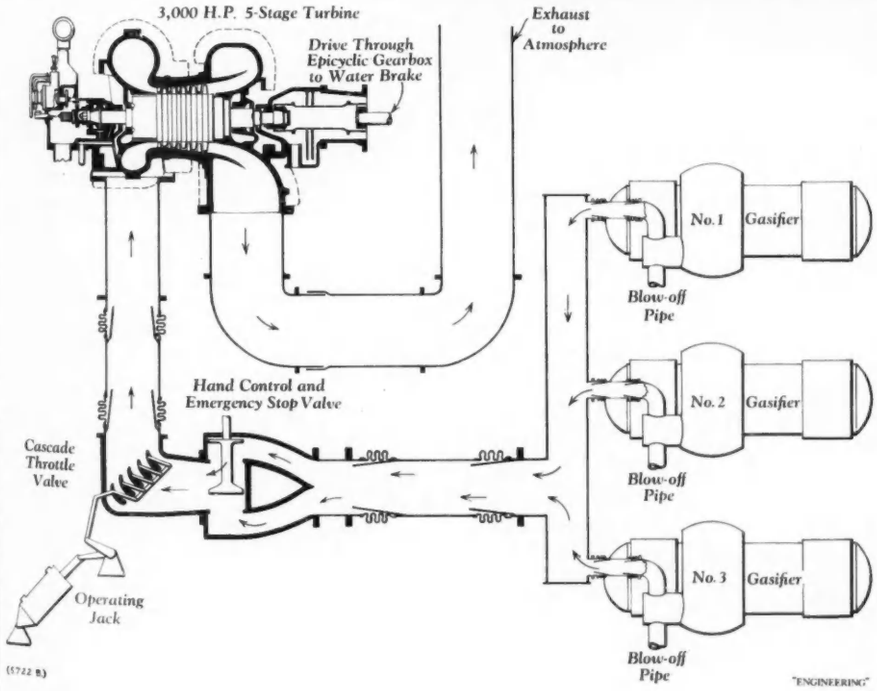
The system displayed at Ashton consisted of a 2,000 h.p. turbine designed for the above contract, with the associated stop and throttle valves situated in the gas inlet ducting. Gas was supplied by three National GS34 gasifiers. For the purpose of the test, the power was absorbed by a water brake driven through an Allen epicyclic gearbox. The throttle valve was the same as the type to be supplied for the contract and, as is indicated in the diagram of the test rig, was mounted in a casing that forms the right angle bend at basement level immediately under the turbine. The gas control element of the valve comprises five cast stainless steel vanes positioned in the bend so as to form a cascade. The vanes are carried by carbon bearings and can be rotated in unison by means of a link and lever system. Vane position controls the flow area.

The carbon bearings are located in self-aligning steel bushes secured in side plates bolted to the casing. The journal portions of extension shafts on the vanes are Stellited and ground to provide a wear resistant bearing surface. An outer cover plate is secured to the side plate, and carbon seals are fitted between it and the bushes to reduce gas leakage to atmosphere. The spaces between side plates and cover plates are vented to the exhaust casing so that the carbon seals are required to seal only against exhaust back pressure. The outer ends of the vane extensions are splined to take forged torque arms—five on each side. These are connected to a common link that is in turn connected to another torque arm splined to a stub shaft journalled in a support. On the outside of this shaft is a lever which is connected to the operating gear. Because of the operating temperature, all connections to the links are made by nitrided pins running in nitrided bushes pressed into the links and torque arms.



Three National 1,250 g.h.p. free piston gasifiers and a Brush gas expansion turbine are shown undergoing tests as a combined system.

The general layout of the test system is shown in this diagram. The throttle valve is mounted vertically under the turbine inlet.



From the throttle valve, the gas is ducted into the turbine inlet casing. Cast integrally with the cylinder, the inlet casing is designed to reduce losses and to impart a measure of prewhirl to the gas entering the first stage stator blading. The gas is expanded in five stages of free vortex reaction blading and passes into the exhaust duct through a diffuser and the exhaust casing.

The turbine casings are cast in four parts in heat resisting carbon molybdenum steel. The casings are split on the horizontal centre line and vertically between the cylinder and exhaust casing; the latter joint is made for manufacturing purposes. The casings are supported so that expansion can take place freely in all directions from one fixed point, at the same time correct alignment being maintained with the driven machine. The exhaust end of the machine is supported by two plates which permit lateral movement by flexure but locate the turbine axially. Lateral location is by centring keys. The inlet end is supported by three legs that are pin jointed to allow free movement along an axis through each leg and the datum point. All supports are outside the turbine lagging and are therefore uniformly cool, maintaining the centre line of the turbine at a virtually constant height above the datum.

With this method of support and the anchoring

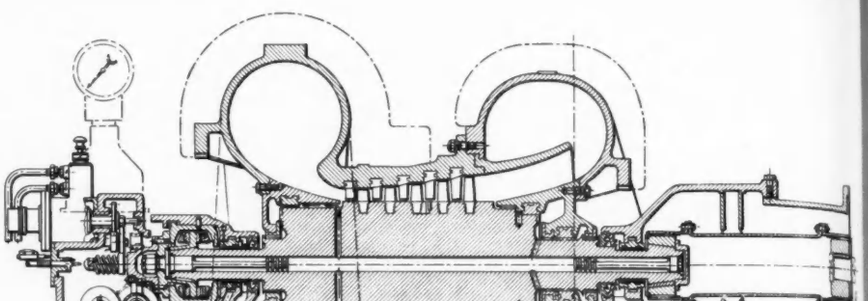
Continuing **Design**

of the stop and throttle valve casing in the basement, relative movement between the flanges occurs and expansion bellows are necessary in the interconnecting ducting. A cold pull up is imposed so that the turbine casings are relieved free from expansion loads at the full working temperature. There remains the separating load on the turbine casings and throttle valve body due to the internal pressure in the duct. At the exhaust end, the ducting is solidly bolted to the turbine casing, and free expansion of the assembly must be allowed.

BEARINGS

The governor-end and exhaust-end bearing housings are supported on the turbine casings through radial keys which permit relative radial movement between casings and bearing housings while maintaining concentricity. The keys, three in the bottom half of each housing, are in the form of round dowels which locate in reamed holes, the centre lines lying on the joint line between the housings and the casings. Spring plate assemblies clamp housing, dowel, and casing together. The differential movement during transient temperature conditions takes place in the key and between a small raised face on the spring plate and the face of the housing.

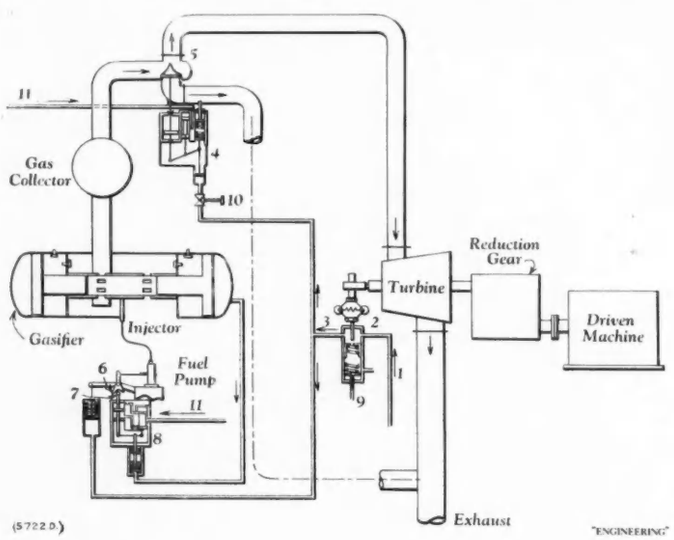
The governor end-bearing shell is rigidly located in both halves of the housing and is supplied with lubricating oil through internal drilled passages. The Michell type thrust bearing, designed to take thrust in either direction, is located in a separate housing that permits self alignment. An auxiliary thrust face is provided on the end of the thrust housing to come into use should a failure occur in the main pads, thus safeguarding the blading and rotor from damage. Mercury-in-steel thermometers measure journal and thrust oil temperatures.



The turbine designed for the ICI installation employs rotor heating when acting as a standby.

ferritic creep-resisting steel. Both rotor and stator blades are provided with " rubbing " tips, which prevent serious damage if fouling of the casing or rotor should occur. Plugs screwed into the bore of the shaft at each end isolate the journal surface from rotor heating gas which is passed through the bore. A taper at the exhaust end of the shaft locates the hub of the tooth coupling and the sleeve transmits the power to the driven machine through a tubular shaft. The sleeve is balanced separately from the ing by a garter spring, and integrally formed fins on the shaft. The carbon permits the fins to rub under marginal clearance conditions without damage. In this manner the seal clearance and hence, the gas leakage, is kept to a minimum. The vernier labyrinths are provided as an auxiliary seal to minimise the leakage of gas and the subsequent rise in thrust load which would be caused by a failure of the carbon seals.

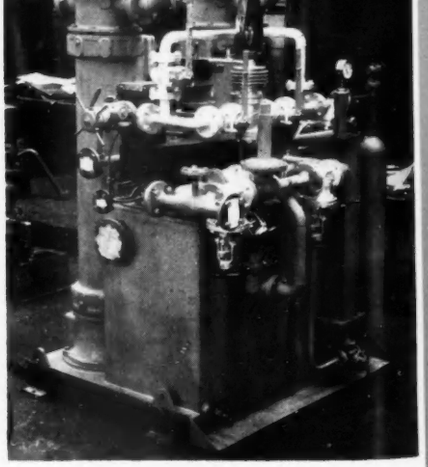
Hot gas introduced between the inner and outer exhaust end seals for balancing purposes



The control system for the gasifier-turbine plant.

1. Supply of oil for control system (usually from turbine ancillary oil pump).
2. Turbine servo governor.
3. Control oil, pressure modulated.
4. Blow-off valve servo motor.
5. Blow-off valve.
6. Min.-max. fuel cam.
7. Stop for min.-max. fuel cam (incorporated in fuel pump timing control).
8. Fuel pump timing control.
9. Speed adjustment.
10. Manual override on blow-off valve control.
11. Operating oil supply (usually from piston cooling oil pump).

The pump side view of the lubricating oil unit shows the steam-driven auxiliary oil pump, with the automatic steam valve controlled by oil pressure, on the left. In front are the relief and reducing valves with by-passes.



A centrifugal governor is mounted on the top half casing, and is driven by a worm gear from the rotor shaft. The mechanical tachometer is driven from an extension to the governor shaft. Mechanical and electrical overspeed trips are driven through a lay-shaft by spur gears off the rotor shaft. The mechanical trip is of the eccentric ring type with an unstable characteristic operating a valve in the control oil circuit. The electrical trip comprises a tacho-generator which, together with a remote relay provides a signal at an overspeed which can be selected.

A shaft position indicator is mounted on the end of the bearing housing: one pointer shows the shaft position at rest; a second indicates the normal shaft position when the operating button is depressed during running; the third pointer can be set to indicate wear in the thrust bearing.

The solid rotor shaft is forged from a stainless rotating assembly, which is balanced after final machining and blading by inserting weights in grooves at each end.

PRESSURE BALANCE

The resulting axial thrust due to the pressure distribution through the blading is minimised by a system of pressure balancing. At the inlet end, the area acted on by full gas pressure is reduced by a system of vernier and carbon seals, the space behind these seals being connected to the exhaust duct. At the exhaust end a similar system of seals retains gas supplied at turbine inlet pressure, which acts on the shaft end face to oppose the combined load due to the area upstream of the inlet end seal and the pressure drop across the blading. The primary seal is formed in both cases between segmented carbon rings, retained on spigots in the stationary hous-

passes through the central bore of the rotor shaft to be expanded across the blading with the main gas stream. In this way the transient thermal stresses in the rotor after starting and the permissible time required to reach full load are both reduced.

STANDBY HEATING

One of these turbines is normally used for standby duties and must be ready for immediate service at all times. To reduce the time required to put the machine on full load, the rotor is heated by a small quantity of hot gas and is continuously barred to ensure an even rotor temperature and to prevent " hogging."

Gas for rotor heating during barring and for sealing purposes when running is controlled by a valve. Steel casings enclose a double beat stainless steel valve, the position of which is controlled by a piston. A spring acting downwards keeps the valve in one position, so that gas is fed from the turbine inlet ducting. Control oil is fed through a solenoid-operated valve during barring and acts against the spring, forcing the valve up to a second position, closing the gas feed from the turbine inlet ducting, and allowing gas piped from a point upstream of the top valve to flow to the turbine. When the barring motor is running, the stop valve is closed and the solenoid valve is energised from the rotor circuit, and passes oil to the piston. When the barring motor is switched off preparatory to starting the plant, the solenoid valve is de-energised, allowing the spring to move the valve to the correct position for normal running. Pressure switches ensure that the barring sequence cannot be started until lubricating oil pressures are correct.

The emergency stop valve is situated in the basement with the throttle valve. The two are mounted together on a common bedplate bolted to a plinth, and the unit thus forms an anchor point for the duct inlet system. Housed in a heat resisting steel casing, the double beat stainless steel emergency stop valve seats on a stainless steel ring and is a close fit in the casing at the lower end. It is guided by a nitrided spindle and the bush in the housing. An operating handwheel is located at the turbine floor level.

The lubricating oil unit is located in the basement independent of the turbine. It supplies lubricating and control oil to the turbine and control system. A oil tank of 130 gallons is fabricated integrally with a bedplate on which are mounted twin oil coolers connected by a changeover valve, which permits operation of one cooler while the other is being serviced. The main oil pump is totally immersed and driven by a flameproof motor.

The auxiliary pump is mounted in a similar manner but driven by a steam turbine. The turbine is governor controlled and is brought into operation automatically by a steam starting valve which is provided with a by-pass line controlled by valves. Both pumps discharge into a common line through check valves, into a duplex full flow filter with changeover valve. From the filter, the oil flows through the cooler and then into the main feed line. A branch on this line supplies control oil and the relief valve maintains pressure.

To safeguard against low oil pressure during the changeover period from main pump to auxiliary, an accumulator is charged with nitrogen from a bottle at normal oil pressure and connected to the main oil gallery. To cater for operation at low ambient temperatures a steam heating line is built into the tank base to warm the oil.

CONTROL SYSTEM

The turbocompressor plant is controlled during normal running by signals from a centrifugal governor driven off the turbine rotor shaft, or by an air signal received from a pressure-sensitive device on the compressor inlet duct. These signals are fed into a receiver unit that responds by passing oil into a hydraulic jack changing the position of the throttle valve vanes.

The centrifugal governor produces an angular deflection of layshaft proportional to speed change. This movement is transmitted through a relay shaft, lever, and spring to produce a load change on the end of the spool of a Hobson transmitter unit. The change causes a displacement of the spool, proportional to the spring load, which in turn causes a change in pressure in the pipeline to the Hobson receiver unit. A simple spring balance servo piston is displaced by the pressure change and moves the spool of a port valve. The port valve movement controls the admission of oil to a double acting hydraulic jack. The port valve is acted on by two additional forces: from a spring system producing a variable load in response to the movement of a feedback lever and cam; and from a spring-loaded diaphragm whose deflection is controlled by the air signal from the compressor —when the governor signal is inoperative.

Under governor control, speed changes can be hand controlled by the speeder gear, comprising a worm drive operating a torsion spring which biases the governor.

SAFETY PRECAUTIONS

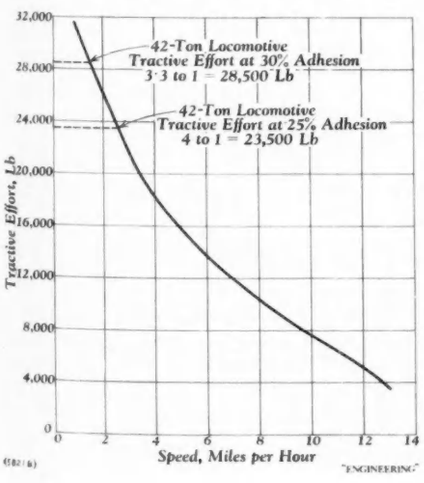
The installation is protected by mechanical and electrical overspeed trips and by a device sensitive to low lubricating oil pressure. Housed in the top half of the governor and bearing housing, the mechanical trip comprises a spring-loaded ring which moves out at predetermined speed, striking a lever which trips a spring loaded plunger releasing control oil pressure. A tacho-generator mounted on the same shaft as the mechanical trip works in conjunction with a moving coil relay which can be preset over a wide range of speeds to allow checking of trip circuit. The moving coil relay works in parallel with pressure switches in the turbine and compressor lubricating oil circuits. Low oil pressure closes contacts in the same way as the relay, energising a solenoid valve which releases control oil to drain. Operation of each device releases control oil pressure, thus closing the emergency stop valve.

DIESEL *with* TORQUE CONVERTER DRIVE

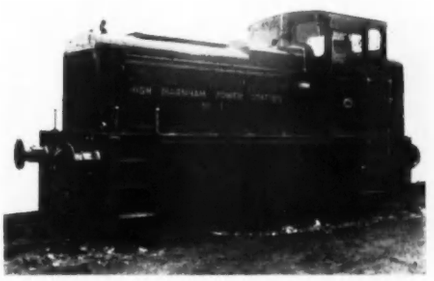
A 302 h.p. diesel hydraulic locomotive, capable of an exceptionally high tractive effort for a four-wheeled locomotive, is now in daily use with the Central Electricity Generating Board. Built by Andrew Barclay, Sons and Company Limited, Kilmarnock, it is the first of four ordered by the Board for handling coal at their new power station at High Marnham.

The weight of the locomotive in working order is 42 tons and the maximum tractive effort is 28,500 lb at 30 per cent adhesion and at 1½ m.p.h. It will run up to a maximum speed of about 14 m.p.h. with light loads, as shown on the tractive effort speed curve. The locomotive will start a load of 1,600 tons on the level, assuming a starting resistance of 18 lb per ton, and will haul this load at a maximum speed of 2½ m.p.h. It will haul 1,000 tons at 5 m.p.h. on the level. The locomotive is powered by a Rolls-Royce C8SFL eight-cylinder supercharged engine which develops 302 b.h.p., 12 hour rating, at 1,850 r.p.m.

The efficiency of the Twin Disc three-stage torque converter, which Rolls-Royce make under licence, is very high. The torque multiplication of 5 or 6 to 1 from a single converter is said to be almost as good as that obtained by combining converters and gearboxes in other systems of transmission. As the necessary torque multiplication can be obtained in one unit, there is no necessity for change-over valves or complicated mechanisms to ensure engagement of gears at the appropriate speeds. In fact, the system of transmission on these locomotives is as simple as it can possibly be made, both in construction and in operation. The driver controls the train and the speed by use of the throttle and brake levers only. Between the engine and the torque converter there is a plate-type friction clutch to avoid running the torque converter while the locomotive is standing, and also to facilitate reversing by removing the drag of the torque converter from the reversing gear teeth. This clutch is engaged with the engine idling and is not used to take up the load; consequently there is practically no wear upon it.



Tractive effort/speed curve.



The first of four 302 h.p. diesel hydraulic locomotives, of exceptionally high tractive effort, for service at High Marnham power station.

The torque converter uses fuel oil as its working fluid and this oil is constantly changing as it circulates back to the tank through a bleed orifice. Pressure is maintained in the converter by means of a gear pump mounted on the engine; a filter is fitted in the circuit. The heat exchanger for the torque converter is of ample proportions to prevent any possibility of overheating when hauling heavy loads. As a precaution against overheating of the converter fluid at high speed when running light, an output shaft governor is provided which limits the maximum speed of the locomotive.

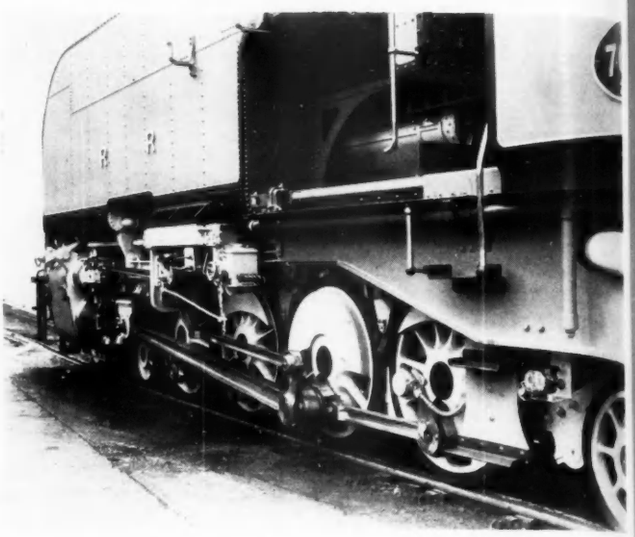
The fuel tank, at the top of the engine casing, holds 200 gallons, sufficient for six day's work under normal day-shift working.

Continuing **Design**

RHODESIA
prefers
STEAM LOCOMOTIVES

In countries where supplies of water and fuel are at hand, and where the smoke nuisance is not an overriding consideration, the steam locomotive may provide a cheaper form of motive power than its younger rivals. One such area is Rhodesia, where rail traffic is steadily expanding (in the year ending March, 1958, the tonnage carried amounted to 11,682,812, almost treble that handled in 1947). To cope with the increasing volume, Rhodesia Railways have carried out much expansion and improvement in recent years, including extensive re-laying with 80 lb rail, and increasing the motive power resources.

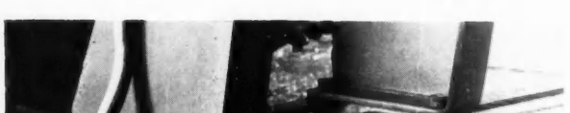
Beyer-Garratt locomotives, since their introduction in 1926, have worked the bulk of the heavy traffic. Orders for this type of locomotive have totalled 250 engines, some of which have achieved a mileage of 10,000 a month, and several of which have covered well over 1,000,000 miles. Deliveries in recent years have included the 20th class, 15 of which were built in 1954.



The rear engine unit of the Beyer-Garratt 20A class locomotive.

Beyer-Garratt Locomotive Class 20A : Leading Particulars

Axle load	17 tons
Adhesive weight	136 tons
Total weight (in working order) approx.	225 tons
Tractive effort at 85 per cent B.P.	69,330 lb
Tractive effort at 75 per cent B.P.	61,180 lb
Boiler pressure	200 lb/sq. in
Grate area	63·1 sq. ft
Coupled wheel diameter	4 ft 3 in
Wheel base rigid	13 ft 9 in
Length over buffers	95 ft 0½ in
Curvature	275 ft radius, $\frac{3}{4}$ in widening, $4\frac{1}{4}$ in superelevation



The Integra warning device is operated by magnets placed between the tracks.

These locomotives were the first designed with the heavier axle load made possible by the use of 80 lb rail, and are able to handle trains of 2,000 tons. It is interesting to compare the maximum tractive effort of 69,330 lb on 17 ton axle load obtained with the 4-8-2 2-8-4 wheel arrangement of the Beyer-Garratt locomotives with that of the Britannia class 4-6-2 locomotive, 32,150 lb on 20-25 ton axle load. Moreover, because the Beyer-Garratt locomotive has a Standard mechanical stoker the potential power is not limited by stoking considerations and can be continuously employed. Other noteworthy design features are the Hadfield precision power reverser, roller bearing axle-boxes on the carrying axles, and the Beyer-Peacock self-adjusting pivot.

This latter feature has proved to be one of the most important improvements in articulated locomotive design. Continuously immersed in an oil bath, the amount of wear on the pivot is extremely small, and it is automatically and immediately taken up. Dismantling of the pivot centres for examination, when the locomotive is shopped for general repairs, is no longer necessary.

Of the most recent deliveries, 40 locomotives, known as the "20A" class, embody slight modifications. The "20th" class had bogie and truck wheels of differing diameter; in the 20A class the diameter of 2 ft 9 in is common to all carrying wheels. The fuel employed is locally mined at Wankie Collieries.

Two of the locomotives have been equipped with approach warning devices (Integra system) to give ample warning to a driver by audible and visual means that he is approaching a place where special vigilance is required. Magnets, placed between tracks at places where it is necessary to warn the driver, operate receiving relays fitted to the locomotive. These relays are connected, by way of an automatic switching mechanism, to a cancelling button, a visual control unit, and a warning horn. The receiving relays, which operate in conjunction with the direction of the locomotive, cause the horn to sound and a blue light on the visual control unit to extinguish.

If the driver does not heed this warning and cancel it by the push-button, then within six seconds of the horn sounding an emergency brake application will be made, a red light will be switched on and an electrical counter in the visual control unit will advance one number. The driver cannot then restore the correct functioning of the approach warning gear until he brings the train to rest, climbs out of the cab and re-adjusts the handle on the apparatus case. After the journey the visual electrical counter can be checked and the reason for any emergency brake applications made during the journey can be ascertained from the driver. The equipment on the locomotive must, initially, be set by the driver for forward or reverse direction of the locomotive before commencing the journey, otherwise the approach warning device will come into operation at every track magnet.

The design of the locomotives is to the requirements of the Chief Mechanical Engineer of the Rhodesia Railways. The contract was under the supervision of Freeman, Fox and Partners, consulting engineers to the Railway, and the locomotives were supplied by Beyer Peacock and Company Limited, Buckingham Gate, London, S.W.1.

PATROL BOAT EXCEEDS 50 KNOTS

HMS Brave Borderer, the first of two of a new class of fast patrol boats engined by gas-turbines, has exceeded 50 knots during its preliminary trials. The trials are being made out of the yards of her builders, Vosper Limited of Portsmouth.

The turbines are marine Proteus designed and built by Bristol Aero-engines Limited; basically, this engine is the same as the Proteus used in the Britannia airliner, though it is operated at a much lower rating to ensure the longer life required in naval vessels. Brave Borderer has a displacement of 75 tons and is 96 ft long.

With a half-hour rating of 3,500 h.p. and a continuous rating of 2,800 h.p., the marine Proteus has a weight of only 2,900 lb. Its specific weight at the maximum rating is 0·83 lb per h.p.—including the primary reduction gear-box which has been designed and made by W. H. Allen and Sons of Bedford. Full reversing and speed reduction are effected through a gearbox which weighs very nearly as much as the turbine unit itself. A very high degree of manoeuvrability has been achieved by Vosper designed electro-hydraulic steering gear in conjunction with three rudders which enables the helm to be put hard over at full speed.

Research and Development

ABSOLUTE CO-ORDINATES *New Design Concept for Machine Tools*

"I come now to the mechanical implications of the new powers with which science is progressively endowing the designer of machine tools. What are their implications? To illustrate some of them I will consider the design of a knee and pillar type of milling machine. The outstanding defect of this design is that from the standpoint of resistance to bending moments it could scarcely be worse! Its merit is its geometrical simplicity. It is the design of a man imbued with a proper respect for Cartesian geometry in three dimensions and the conceptual simplicity and straightness of straight lines."

The Rt. Hon. the Earl of Halsbury was nearing the end of his lecture, given before the Manchester Association of Engineers; its title was "Electromechanical Themes in Machine-Tool Design." Earlier, he had given a lucid description of computing techniques for machine tools. Now he continued: "Imagine, however, that some competitive designer's geometrical intuition was based on projective geometry and homogeneous co-ordinates. He would start off with a pinjointed tetrahedral frame, from the four vertices of which four hydraulic rams would project towards the centre controllable and articulated in such a way that a force could be brought to bear in any direction at any point within the structure. Being eager to make his co-ordinate axes conform as nearly as possible to mathematical straight lines he would make them as slender as he could, subject to their remaining within the elastic limit under any loads which might be imposed on them. Imagine the outraged feelings of any conventional machine-tool designer on being shown so abominable a travesty of what a respectable system of supports should look like! 'It can't even draw a straight line without a long trigonometrical calculation,' he would first complain. Agreed. But computers make light work of long trigonometrical calculations. 'But those spidery tie-rods,' he might continue, 'they'll deform elastically up to 0·1 per cent; the reaction at the hinges will mean that your tool tip may be up to one-tenth of an inch away from its nominal position.' Agreed. But what does that matter if its static position is not a nominal one calculated in terms of a stressed framework but an absolute one determined by an external co-ordinate system? (Its dynamic position is, of course, a different matter.) In the words of one engineer alive to all these possibilities: 'We can now begin to design boneless wonders'."

Lord Halsbury was not, of course, arguing that anything quite so absurd as the design he had suggested would ever see the light of day. Its absurdity, however, served to show that the objections that immediately occur to one cannot be sustained without analysis, though they might survive if such an analysis were thought worth undertaking. The illustration served to underline the main point of the lecture: the implications of combining the calculating capacity of a computer with an absolute co-ordinate system external to the stressed frames and slideways, which support work and tool-holders in machine tools, are far reaching. Designers will have to be free of all preconceptions of what a machine tool should look like if it is to "look right."

An example of the implications of the use of an absolute co-ordinate system is the automatic correction of the imperfections in a slideway. The imperfections are all at right angles to the direction of the slide. If, however, one slide supports another travelling at right angles to it, the errors in the first are parallel to the direction of motion of the second and their correction can be incorporated into that motion.

Another example is the system being developed at the NPL for the cutting of perfect lead screws. An electronic control synthesises the equivalent of a corrector bar action as the screw is cut. The equivalent of a corrector bar is shaped afresh each time, but there is, of course, no corrector bar in any material sense.

Lord Halsbury suggested that we could claim to be at no more than the beginning of a revolution brought about by these methods, for we were not concerned with some mere extension of the power of machine tools to manufacture their products automatically but with an improvement in the mechanical perfection of the selfsame tools. He added that the kinematics of design would have to be more effectively realised if the potentialities of the new methods were to be fully exploited. At the slide-speeds and general rates of movement involved, friction must be reduced and stiction eliminated if the tool were to be the obedient slave of its tape controller.

In conclusion, Lord Halsbury outlined the situation he saw the machine-tool industry in. "The machine-tool industry has for a long time past been one of those where practical experience counted for a lot. Basic innovation tends to render such an industry a little breathless inasmuch as where experience is non-existent it cannot count for very much. In the whole field of electromechanical devices such as I have discussed tonight experience is still more or less primitive. This is an encouraging thought, for it means that the most interesting developments still lie ahead."

TWISTOR SHIFT REGISTER

A reversible, diodeless shift register using a single magnetic wire as the memory element is under development at Bell Telephone Laboratories, 463 West Street, New York, 14. The device takes advantage of the "twistor" technique (ENGNG., vol. 184, p. 824, 27 Dec. '57). Shift registers are used in most digital computers and in many other applications; they are essentially temporary storage devices and perform much the same function as delay lines except that the stored pulses can be shifted at will. Tests on a five-advance twistor register have demonstrated the feasibility of the device: it is capable of storing three bits per inch and calculations show that the capacity can be increased to ten bits per inch. The upper frequency limit has not been established, but a several hundred kc/s bit rate should be possible.

The five-advance twistor shift register is suitable for computers and, as no diodes are required, a reduction in drive power is possible.

A wire of magnetic material when twisted can be most easily magnetised in a spiral direction and can store pulses in this manner when subjected to a suitable magnetising field. The amount of twist applied serves to regulate the magnetic interaction between magnetised zones. The zones can be slid along the wire under the control of externally applied multi-phase advance pulses. In the experimental shift register, information bits are written in and slid along by means of tiny 8-turn solenoids, each one being 0·075 in long. The coils are spaced 0·075 in apart and are wound on a ceramic tube. Through the centre of the tube is stretched the magnetic wire—0·002 in diameter Permalloy. The five-advance register is shown in the illustration.

Simultaneous pulsing of three adjacent coils is necessary to insert a magnetised zone into the register. Two coils must be pulsed to slide the zone along the wire. For example, if a bit is stored by pulsing coils 1, 2, and 3, it can be moved along one space by properly pulsing coils 1 and 4. The pulse current required for the advance operation is about 140 mA. To clear the wire after the bit has been advanced, the erase coil is pulsed with about 240 mA. To read a signal out at the end of the register, a pulse of about 170 mA is passed through three read out coils. Bi-directional operation is easily secured.

INTERCHANGING PROGRAMMES

To inaugurate a scheme for the interchange of information on programmes for the Mercury computer, Ferranti Limited have published a document containing details of the programmes of which they have been informed. The lists will be issued from time to time, giving the name of the author of each programme and the organisation he works for. The aim is to enable any other worker to get in touch with the originator of a programme if he requires further details of it.

For the scheme, short fully descriptive titles are required of about 6 to 12 words: not comprehensive write-ups of the programme. The programmes have been classified under the following groups: commercial and data processing; general engineering; input, output, and conversion; mathematical; operational research; organisation and checking of programmes; input; output; and various special subjects. To have a programme included in future issues of the document, details should be sent to Ferranti Limited, 21 Portland Place, London, W.1.

In the present list, the section, "special subjects" includes crystallography, atomic physics, and meteorology. The atomic physics programmes come from AERE, Harwell, and include a programme for solving multi-group neutron diffusion equations in two space dimensions and a programme for solution of a neutron transport equation, using one-dimensional spherical or cylindrical geometry, enabling reactivity and critical size calculation. The meteorology programme provides for an analysis of 500 mb contour and 1,000-500 mb thickness fields for a set of 24 by 20 points.

Continuing **Research and Development**

DYNAMICALLY ISOLATED VIBRATION TEST RIG

Effect of Isolation on Natural Frequency of Cantilevered Blade-type Testpieces

By WILLIAM CARNEGIE, PH.D., B.SC., A.M.I.MECH.E.
Lecturer in Mechanical Engineering, University of Birmingham

In order to prevent the transmission of alternating forces to the surroundings, a blade vibration test rig can be dynamically isolated. The exciter, usually of relatively heavy weight, is suspended from a spring of low stiffness (Fig. 1) and, thus, the natural frequency of the exciter-spring system will be low relative to the natural frequencies of the blade under test. Hence, as can easily be shown by the well-known vibration isolation theory[1] the forces transmitted are only a fraction of those imposed. Similarly, the blade-root clamping block can be supported on soft sponge rubber. Provided that the clamping block is of heavy weight and large polar moment of inertia, the natural frequencies of the clamping-block/sponge-rubber system will also be low relative to those of the blade. Thus, the requisite conditions for almost complete dynamic isolation of the test rig are fulfilled. This arrangement, however, will modify to some extent the numerical values of the blade natural frequencies, due to the insertion of the soft sponge-rubber pad under the clamping block. The purpose of this article is to show, theoretically, the conditions to be fulfilled in order to reduce to a minimum the alteration in blade natural frequency due to isolation of the clamping block from the rigid base. The following notation is used throughout the analysis.

Notation

A′, B′, C′, D′, E′, F′, constants.
C, torsional stiffness of blade.
E, modulus of elasticity of blade material.
I, polar moment of inertia of blade about line of centroid.
I_c, polar moment of inertia per unit length of blade about line of centroid.
I_θ, polar moment of inertia of clamping block about *zz* axis.
I_{xx}, second moment of area of blade cross-section about *xx* axis.
K, stiffness of sponge-rubber pad in *y* direction.
K′, torsional stiffness of sponge-rubber pad.
L, length of blade.
W, weight of clamping block.
g, gravitational acceleration.
k, lateral frequency " constant."
m, weight of blade.
n, odd integer.
p, natural circular frequency of transverse (lateral) vibration of blade.
p_n, natural circular frequency of torsional vibration of blade.
p_y, natural circular frequency of vibration of clamping-block/ sponge-rubber system in *y* direction.
p_θ, natural circular frequency of torsional vibration of clamping-block/sponge-rubber system.
w, weight per unit length of blade.
y, displacement in *y* (vertical) direction.
y_L, displacement of blade-root cross-section in *y* direction.
z, co-ordinate distance measured along blade from tip.
c.g., centroid of blade cross-section.
zz, longitudinal axis.
θ, torsional displacement.
θ_L, torsional displacement of blade-root cross-section
λ, torsional frequency " constant."

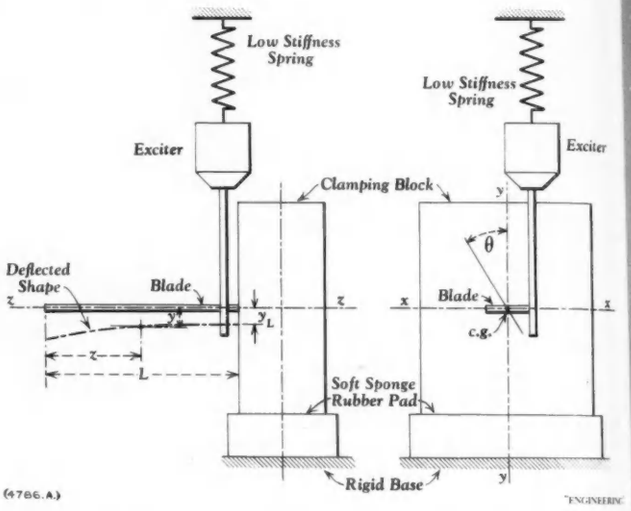


Fig. 1 A dynamically isolated blade vibration test rig.

When a blade of rectangular or other symmetrical cross-section executes transverse harmonic vibrations the characteristic differential equation can be written as follows:—

$$\frac{d^4y}{dz^4} - k^4y = 0 \quad . \quad . \quad (1)$$

where

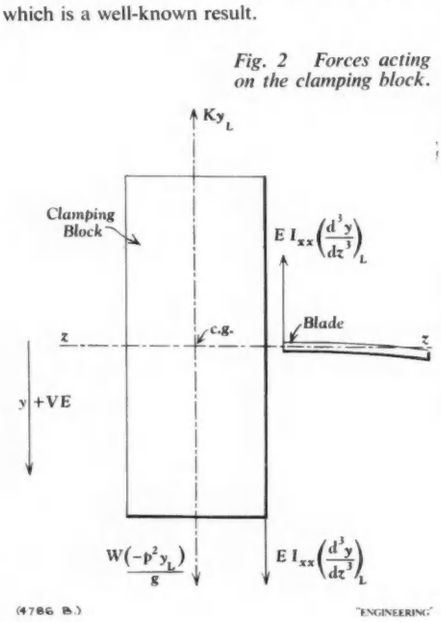
$$k^4 = \frac{wp^2}{EI_{xx}g} \quad . \quad . \quad . \quad (2)$$

The general solution of equation (1) is, thus, given by

$$y = A' \sin kz + B' \cos kz + C' \sinh kz + D' \cosh kz \quad (3)$$

which is a well-known result.

Fig. 2 Forces acting on the clamping block.



At the free end of a cantilever blade, i.e., $z = 0$, the bending moment $EI_{xx}\left(\frac{d^2y}{dz^2}\right)$ and the shearing force $EI_{xx}\left(\frac{d^3y}{dz^3}\right)$ are each equal to zero and, making use of equation (3), it can easily be shown that $B' = D'$ and $A' = C'$.

At the root end of the blade, i.e., $z = L$, the slope $\frac{dy}{dz} = 0$, the blade being mounted encastré in the clamping block which is assumed to move in a purely vertical direction only. Hence, by differentiation of equation (3), the following relationship can be deduced, viz,

$$A' = \frac{B'(\sin kL - \sinh kL)}{(\cos kL + \cosh kL)} \quad . \quad (4)$$

A second condition at the blade root is obtained by consideration of the forces acting on the clamping block. Fig. 2 shows the forces acting on the block when co-ordinate *z* is measured positive towards the root and an equilibrium equation can, thus, be written as follows,

$$EI_{xx}\left(\frac{d^3y}{dz^3}\right)_L - Ky_L = \frac{W(-p^2y_L)}{g} \quad (5)$$

or, in words, the shearing force at the blade root minus the force of the sponge-rubber pad is equal to the inertia force due to the clamping block.

Expressions for y_L and $\left(\frac{d^3y}{dz^3}\right)_L$ can easily be obtained. Hence, by use of equation (4) the following two equations result, viz,

$$y_L = \frac{2B'(1 + \cos kL \cosh kL)}{(\cos kL + \cosh kL)} \quad . \quad (6)$$

$$\left(\frac{d^3y}{dz^3}\right)_L = \frac{k^3 2B'(\cosh kL \sin kL + \cos kL \sinh kL)}{(\cos kL + \cosh kL)} \quad . \quad . \quad . \quad (7)$$

Substitution of these two equations into equation (5) gives, after some rearrangement

$$(1 + \cos k\,L \cosh k\,L) = \frac{m/W}{\{(p_y^2/p^2)-1\}}\left\{\frac{\cosh kL \sin kL + \cos kL \sinh kL)}{kL}\right\} \quad . \quad . \quad . \quad (8)$$

When $p_y^2 \ll p^2$, where $p_y^2 = \frac{K\,g}{W}$, then the stiffness K of the sponge-rubber pad must be small and the weight W of the clamping block correspondingly large. Thus, for an additional condition that $W \gg m$ ($m = w\,L$) equation (8) reduces to

$$(1 + \cos k\,L \cosh k\,L) = 0 \quad . \quad (9)$$

approximately. Thus, equation (8) approaches, closely, the standard equation (9) from which the natural frequencies of an encastré cantilever blade are obtained. That is to say, with the above conditions ($p_y^2 \ll p^2$ and $W \gg m$) satisfied simultaneously, the blade-root clamping can be considered to be almost encastré.

Torsional vibrations of a blade can be treated in a similar manner. The characteristic equation of a straight blade of rectangular cross-section is

$$\frac{d^2\theta}{dz^2} + \lambda^2\,\theta = 0 \quad . \quad . \quad (10)$$

where

$$\lambda^2 = \frac{I_c\,p_n^2}{C\,g} \quad . \quad . \quad (11)$$

The general solution of equation (10) is given by

$$\theta = E' \sin \lambda z + F' \cos \lambda z \quad . \quad (12)$$

At the free end of a cantilever blade ($z = 0$) the torque $C\frac{d\theta}{dz} = 0$ and, thus, it follows that $E' = 0$.

The terminal condition at the blade root is obtained by considering the torques acting on the clamping block. These are shown in Fig. 3 and are related by the following equation:—

$$\frac{I_\theta\,(-p_n^2\,\theta_L)}{g} = -C\left(\frac{d\theta}{dz}\right)_L - K'\,\theta_L \quad (13)$$

since when θ is positive $\frac{d\theta}{dz}$ is negative, z being measured positive towards the root. Thus, the torque at the blade root minus the torque of the sponge-rubber pad is equal to the inertia torque due to the clamping block. Substitution of equations for θ_L and $\left(\frac{d\theta}{dz}\right)_L$, obtained from equation (12), into equation (13) gives, after rearrangement

$$-\frac{I_\theta}{I} = \frac{1}{\left\{1 - \frac{p_\theta^2}{p_n^2}\right\}} \cdot \frac{\tan \lambda L}{\lambda L} \quad . \quad (14)$$

When $p_\theta^2 \ll p_n^2$, where $p_\theta^2 = \frac{K'\,g}{I_\theta}$, then the torsional stiffness K′ of the sponge-rubber pad must be small and the moment of inertia I_θ of the clamping block correspondingly large. Thus, for the further condition that $I_\theta \gg I$ ($I = I_c\,L$), equation (14) reduces to

$$\frac{\tan \lambda L}{\lambda L} = -\infty \quad . \quad . \quad (15)$$

approximately. Since λL is finite and not equal to zero, except for a trivial case, then

$$\tan \lambda L = -\infty \quad . \quad . \quad (16)$$

and λL thus equals $\frac{\pi}{2}, \frac{3\pi}{2}, \ldots \frac{n\pi}{2}$.

Hence

$$p_n = \frac{n\pi}{2L}\sqrt{\frac{Cg}{I_c}} \quad . \quad . \quad (17)$$

which gives the natural torsional frequencies of a blade mounted encastré at the root. Hence, the torsional frequencies of the blade will not be greatly affected in value by the presence of the flexible mounting when the above conditions ($p_\theta^2 \ll p_n^2$ and $I_\theta \gg I$) are satisfied simultaneously. Thus, as in the case of the transverse vibrations, the blade root clamping can be considered encastré.

The above analyses for both lateral and torsional motions apply to a straight blade of uniform rectangular cross-section. They can be extended to the case of pre-twisted blades of any cross-section but, since all blade motions are made up of both lateral and torsional components, it is suggested that further analysis is not required. It can thus be reasonably assumed that the natural frequencies of any encastré mounted blade are not greatly affected in value by flexibly mounting the clamping block provided that the above stated conditions, for both lateral and torsional motions, are satisfied together. Furthermore, since the requirements ($p^2{}_y \ll p^2$ and $p_\theta{}^2 \ll p^2{}_n$) for dynamic isolation are also satisfied, the transmitted forces and torques will only be a fraction of those imposed.

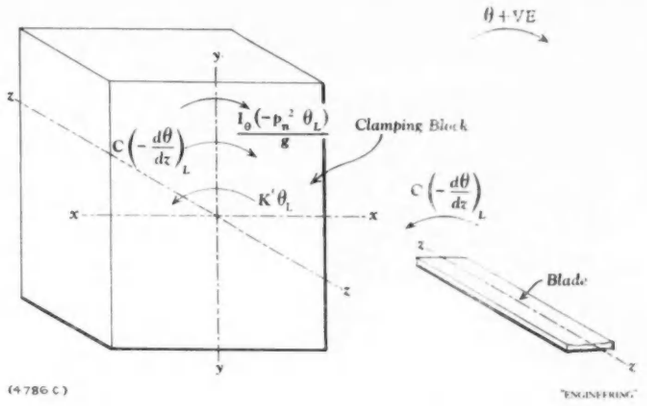


Fig. 3 Torques acting on the clamping block.

In a recent investigation conducted by the author[2] in which the vibrations of pre-twisted blading are examined, a flexible clamping arrangement fulfilling the above conditions is used. Comparison between the measured frequencies and those calculated for an encastré mounted blade indicate that the effect of the flexible mounting on the frequency values is negligible.

REFERENCES

[1] J. P. Den Hartog, *Mechanical Vibrations*, Third Edition. McGraw-Hill, New York and London, 1947.

[2] W. Carnegie, "Vibrations of Pre-twisted Cantilever Blading." Awaiting publication in *Proc. I.Mech.E.*

MAKING CONTACT WITH SEMICONDUCTORS

Large and Small Areas Formed by Thermocompression Bonding

Recent developments in thermocompression bonding by Bell Telephone Laboratories, 463 West Street, New York 14, have made it possible to form large area contacts between metallic leads and semiconductor surfaces. It is also possible, by this process, to attach leads to both sides of a semiconductor wafer simultaneously, thus making the base and emitter contacts at the same time.

In thermocompression bonding, a soft metal lead is pressed against the gold-plated surface of a semiconductor and moderate heat applied. Adhesion generally takes place in a few seconds. Pressures in the range of 12,000 to 20,000 lb per sq. in, and temperatures between 300° C and 325°C are normally used, the pressures being below the deformation point of the semiconductor, and the temperature below the melting points of both the lead and the semiconductor. For large area contacts, gold or silver leads of from 0·006 to 0·015 in diameter are "headed" like nails, the heads being commonly of about 0·030 in diameter. Bonding in this manner is being used at Bell Laboratories to attach leads to diffused silicon diodes: the 0·030 in contact head covers almost the entire active area of the mesa-type diode, allowing the passage of a high forward current.

The bonding process has also proved satisfactory where very small leads (0·0004 in diameter) must be attached to small areas (0·001 in by 0·006 in), as in high-frequency transistors. When applied to diffused-base germanium transistors with alpha cut-off frequencies in the 500 to 1,000 Mc/s range, the technique results in a rugged structure that will withstand 100,000 *g* in a centrifuge, as well as high shocks.

Prior to the formation of the bond, the areas of attachment are treated with evaporated and alloyed metallic films from 1,500 to 3,000 angstroms thick. Annealed gold has been found a satisfactory lead material. To form the bond, the wire is pressed on the prepared area with a tool shaped as a half-cylinder. A force sufficient to produce about 85 per cent deformation of the wire is used. The temperature is held within the annealing range of the lead material during the process, and the bond is formed in a non-oxidising atmosphere. Under these conditions, a bond can be formed, in a second or two, stronger than the lead material itself.

Specification for the use of thermocompression bonding in the commercial preparation of diodes and transistors are being prepared at Bell Laboratories. The method will allow the use of higher bake-out temperatures and is an inherently cleaner procedure than the present methods of attachment. Both considerations would yield greater reliability in the finished semiconductor devices.

CO-ORDINATION OF SPACE RESEARCH

Recently the International Council of Scientific Unions established a Committee on Space Research (COSPAR). It was stated that the chief purpose of COSPAR is to provide a means whereby the scientific community may use to maximum advantage the possibilities of satellites and space probes, and exchange the resulting data on a co-operative basis. At a meeting in November in the rooms of the Royal Society, a constitution for COSPAR was drawn up for approval by ICSU. At this first meeting of COSPAR an executive committee was also elected, having the following officers: president, Professor H. C. van de Hulst, of the International Astronomical Union; vice-presidents, Professor E. K. Fedorov, USSR Academy of Sciences, and Professor W. A. Noyes, Jr., University of Rochester; members, Professor M. Roy, International Union of Theoretical and Applied Mechanics, and Professor H. S. W. Massey, International Union of Pure and Applied Physics. At present much of the work that COSPAR will carry out is undertaken by an organisation set up as part of the IGY.

NOTICES OF MEETINGS

British Institution of Radio Engineers

CARDIFF
"Computer Control of Machine Tools," by H. Ogden. South Wales Section. Cardiff College of Advanced Technology, Cardiff. Wed., 14 Jan., 6.30 p.m.
EDINBURGH
"Satellite Development and the Moon Rocket," by P. H. Tanner. Scottish Section. Department of Natural Philosophy, The University, Drummond Street, Edinburgh. Fri., 16 Jan., 7 p.m.
GLASGOW
"Satellite Development and the Moon Rocket," by P. H. Tanner. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. Thurs., 15 Jan., 7 p.m.

Building Centre

LONDON
Films: "Tale of a Terminal" (West London Air Terminal) and "Costain at Kariba," exhibited by Richard Costain Ltd. Wed., 14 Jan., 12.45 p.m.

Central London Productivity Association

LONDON
Three short papers on "Putting Colour to Work." Federation of British Industries, 21 Tothill Street, S.W.1. Thurs., 15 Jan., 2.30 p.m.

Chemical Engineering Group

LONDON
"An Organisation for Inspection," by E. W. Greensmith. Tues., 13 Jan., 6 p.m.

Combustion Engineering Association

LEEDS
"Mechanical Handling, Storage and Conditioning of Solid Fuels," by W. G. Archer. Northern Region. Hotel Metropole, Leeds. Wed., 14 Jan., 11 a.m.*
MANCHESTER
Brains Trust Meeting on "The Clean Air Act." North Western Region. Engineers' Club, Albert Square, Manchester. Wed., 14 Jan., 2.30 p.m.

Diesel Engineers and Users Association

LONDON
"Multi-Fuel High-Speed Diesel Engines," by H. L. Troughton and R. L. Fowler. Institute of Marine Engineers, 76 Mark Lane, E.C.3. Thurs., 15 Jan., 2.30 p.m.

Illuminating Engineering Society

LONDON
"Designed Appearance Lighting of Gloucester Cathedral," by J. M. Waldram. Federation of British Industries, 21 Tothill Street, S.W.1. Tues., 13 Jan., 6 p.m.
GLASGOW
"An Analytical Approach to Industrial Lighting," by W. Imrie-Smith. Glasgow Centre. British Lighting Council, 29 St. Vincent Place, Glasgow, C.1. Thurs., 15 Jan., 6.30 p.m.

Incorporated Plant Engineers

BLACKBURN
"Education," by the Ven. C. H. Lambert. Blackburn Branch. White Bull Hotel, Blackburn. Thurs., 15 Jan., 7.30 p.m.
BRISTOL
"Nuclear Energy," by Dr. M. D. Wood. Western Branch. Grand Hotel, Broad Street, Bristol. Wed., 14 Jan., 7.15 p.m.
DUNDEE
"Paints and Anti-Corrosives," by Dr. R. A. Sim. Dundee Branch. Taypark Hotel, West Ferry, Dundee. Wed., 14 Jan., 7.30 p.m.
MANCHESTER
"Industrial Law and the Plant Engineer," by C. N. Glidewell. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 13 Jan., 7.15 p.m.
NOTTINGHAM
"A Criticism of Technical Education," by Dr. H. L. Haselgrave. East Midlands Branch. County Hotel, Theatre Square, Nottingham. Wed., 14 Jan., 7 p.m.

Institute of Marine Engineers

GLASGOW
"Research and Failures of Metals in Service," by C. E. Phillips and A. C. Low. Scottish Section. 39 Elmbank Crescent, Glasgow, C.2. Wed., 14 Jan., 7.30 p.m.
KINGSTON-UPON-HULL
"The Holmes Werkspoor Engine: Building, Testing and in Service," by Bryan Taylor. Kingston-upon-Hull and East Midlands Section. Royal Station Hotel, Kingston-upon-Hull. Thurs., 15 Jan., 7.30 p.m.
NEWCASTLE UPON TYNE
"Centrifugal Purification of Oil," by M. E. O'K. Trowbridge. North East Coast Section. Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne. Thurs., 15 Jan., 6.15 p.m.*

Institute of Marine Engineers and Institution of Naval Architects

LONDON
"Development of Air Conditioning in Ships," by S. J. Jones and J. K. W. MacVicar. Joint Meeting. 76 Mark Lane, E.C.3. Tues., 13 Jan., 5.30 p.m.*

Institute of Metals

SWANSEA
"The Zinc Blast Furnace," by S. W. K. Morgan. South Wales Local Section. Department of Metallurgy, University College, Singleton Park, Swansea. Tues., 13 Jan., 6.30 p.m.*

Institute of Physics

LONDON
"Controlled Thermonuclear Reactions," by the President, Sir George Thomson. Royal Institution, 21 Albemarle Street, W.1. Wed., 14 Jan., 5.30 p.m.

Institute of Road Transport Engineers

BIRMINGHAM
"Taking Stock on Maintenance," by P. H. Wyke Smith. Midlands Centre. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Tues., 13 Jan., 7.30 p.m.
LEEDS
"Trends in Modern Road Passenger Transport," by R. Cox. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 15 Jan., 7.30 p.m.
NOTTINGHAM
"Wear and Tear (Part 2)," by J. E. Johnson. East Midlands Centre. Mechanics' Institute, Nottingham. Wed., 14 Jan., 7.30 p.m.

Institution of British Agricultural Engineers

LONDON
"Ground Adhesion Problems of Wheeled Agricultural Tractors," by A. Senkowski. Tues., 13 Jan., 2.15 p.m.
NEWCASTLE UPON TYNE
"Drainage of Agricultural Land," by G. H. Theobald. Northern Centre. North Eastern Electricity Board's offices, Carliol House, Newcastle upon Tyne. Mon., 12 Jan., 6.45 p.m.

Institution of Civil Engineers

LONDON
"Habbaniyah Flood Relief and Storage Scheme," by R. D. Gwyther, A. P. Humble and R. K. Lewis. Tues., 13 Jan., 5.30 p.m.*
CHESTER
"Off-Shore Boring," by W. H. Brooks. North Western Association. Queen Hotel, Chester. Thurs., 15 Jan., 7.30 p.m.

Institution of Electrical Engineers and British Nuclear Energy Conference

LONDON
"Electrical Installation at Calder Hall Nuclear Power Station," by N. J. Mackay and E. Hardwick. Joint meeting in conjunction with the IEE Utilization Section. IEE, Savoy Place, Victoria Embankment, W.C.2. Thurs., 15 Jan., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "What is the Economic Limit of Mechanical Aid to Field Work," opened by P. F. Clark. Mon., 12 Jan., 5.30 p.m.*
Discussion on "Education and Training from the Students' Point of View." Joint Meeting of the Education Discussion Circle and the London Graduate and Student Section. Tues., 13 Jan., 6.30 p.m.*
"Frontiers of Space Research," by Dr. Robert M. Page. London Graduate and Student Section. Fri., 16 Jan., 6.30 p.m.*
CARDIFF
"Design of the 330 kV Transmission System for Rhodesia," by F. C. Winfield, T. W. Wilcox and G. Lyon. Western Centre. South Wales Institute of Engineers, Park Place, Cardiff. Mon., 12 Jan., 6 p.m.*
LOUGHBOROUGH
"Results of Full-Scale Stability Tests on the British 132 kV-Grid System," by Dr. Ing. F. Busemann and W. Casson. East Midland Centre. Loughborough College, Loughborough. Tues., 13 Jan., 6.30 p.m.*
MALVERN
"Electrostatic Loudspeakers," by P. J. Walker. South Midland Centre. Winter Gardens, Malvern. Mon., 12 Jan., 7.30 p.m.
NEWCASTLE UPON TYNE
"Design and Performance of the Gas-Filled Cable System," by E. P. G. Thornton and D. H. Booth. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 12 Jan., 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"Design in Relation to the Production of Castings," by G. Elston. North East Branch. Northern Architectural Association's hall, 6 Higham Place, Newcastle upon Tyne. Mon., 12 Jan., 7.15 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Engineering Services in the Empire Games Pool, Cardiff," by J. R. Kell. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Tues., 13 Jan., 6.30 p.m.

Institution of Locomotive Engineers

LONDON
"Automatic Train Control—The British Railways System," by J. H. Currey. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, S.W.1. Wed., 14 Jan., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Standards and Standardisation in the Motor Industry," by E. Woodbridge. Automobile Division. Tues., 13 Jan., 6 p.m.*
Discussion on "Boiler Feed Water." Steam Group. Thurs., 15 Jan., 6 p.m.*
"Inherent Non-Linear Effects in Hydraulic Control Systems with Inerita Loading," by J. K. Royle; and "Response of a Loaded Hydraulic Servomechanism," by Dr. D. E. Turnbull. Meeting in conjunction with the Hydraulics Group. Fri., 16 Jan., 6 p.m.*
BELFAST
First annual meeting of the Northern Ireland Branch. Museum and Art Gallery, Belfast. Tues., 13 Jan., 7.30 p.m.*
GLASGOW
"Recent Developments in the Manufacture of Castings," by J. L. Rice, R. W. Ruddle and F. A. Russell. Scottish Branch, Royal College of Science and Technology, Glasgow. Thurs., 15 Jan., 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
Various short papers for discussion. Geological Society, Burlington House, Piccadilly, W.1. Thurs., 15 Jan., 5 p.m.*

Institution of Production Engineers

LONDON
"Plastic Mouldings Production," by L. H. Hayward. Royal Empire Society, Northumberland Avenue, W.C.2. Thurs., 15 Jan., 7 p.m.
LEEDS
"Ceramic Cutting Tools," by G. E. Connor. Leeds Section, Hotel Metropole, Leeds. Mon., 12 Jan., 7 p.m.

Institution of Public Health Engineers

LONDON
"Desalting of Saline Water by Electrodialysis," by W. M. T. Boby. Caxton Hall, off Victoria Street, S.W.1. Thurs., 15 Jan., 6 p.m.

Institution of Railway Signal Engineers

LONDON
"Microwave Radio for Use in Trunk Telecommunication Networks," by P. W. Hanstock. Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Wed., 14 Jan., 6 p.m.*

Institution of the Rubber Industry

LONDON
"Compounding Nitrile Rubber for Specific Properties," by S. E. Bolam; and "High-Temperature Vulcanisation," by Dr. G. Bielstein. London Section. 26 Portland Place, W.1. Tues., 13 Jan., 5.30 p.m.

Institution of Structural Engineers

MANCHESTER
"Some Structures Involving Unusual Design Problems," by C. E. Saunders. Lancashire and Cheshire Branch. College of Science and Technology, Manchester. Tues., 13 Jan., 6.30 p.m.

Junior Institution of Engineers

LONDON
"Engineering Uses of Epoxy Resins," by R. Land. Fri., 16 Jan., 7 p.m.*

Leeds Metallurgical Society

LEEDS
"The Ultimate Structure," by T. J. Parry and S. Newton. Chemistry Wing, The University, Leeds. Thurs., 15 Jan., 7.15 p.m.

Liverpool Engineering Society

LIVERPOOL
"Manufacture of Glass and Its Uses in Industry," by A. E. Owen. Wed., 14 Jan., 6 p.m.

Manchester Association of Engineers

MANCHESTER
"Soil Mechanics," by E. Ll. Morgan. Engineers' Club, Albert Square, Manchester. Fri., 16 Jan., 6.45 p.m.

Newcomen Society

LONDON
"A Lancashire Village's Contribution to the Early History of the Cotton Industry, 1570 to 1812," by R. Walmsley. Wed., 14 Jan., 5.30 p.m.

Reinforced Concrete Association

LONDON
"A Survey of Recent Developments in Reinforced Concrete," by A. W. Hill. 11 Upper Belgrave Street, S.W.1. Wed., 14 Jan., 6 p.m.*

Royal Society of Arts

LONDON
"Road Development in Overseas Territories," by Dr. R. S. Millard. Thurs., 15 Jan., 5.15 p.m.*

Society of Chemical Industry

GLASGOW
"Protection of Motor Vehicles from Corrosion," by S. G. Clarke. Royal College of Science and Technology, Glasgow. Fri., 16 Jan., 7.15 p.m.

Society of Instrument Technology

LONDON
Symposium on "Storage Media." Data Processing Section. 26 Portland Place, W.1. Wed., 14 Jan., 6 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1. (MUSeum 1901.)
British Nuclear Energy Conference, Great George Street, London, S.W.1. (WHItehall 4577.)
Building Centre, 26 Store Street, London, W.C.1. (MUSeum 5400.)
Central London Productivity Association. Apply to Mr. B. E. B. Turner, Shell-Mex & B.P. Ltd., 1 Kingsway, London, W.C.2. (TEMple Bar 8456.)
Chemical Engineering Group, 14 Belgrave Square, London, S.W.1. (BELgravia 3647.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, S.W.1. (WHItehall 5536.)
Diesel Engineers and Users Association, 18 London Street, London, E.C.3. (ROYal 2393.)
Illuminating Engineering Society, 32 Victoria Street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 2 Grosvenor Gardens, London, S.W.1. (SLOane 0469.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave Square, London, S.W.1. (BELgravia 3291.)
Institute of Physics, 47 Belgrave Square, London, S.W.1. (BELgravia 6111.)
Institute of Road Transport Engineers, 69 Victoria Street, London, S.W.1. (ABBey 6248.)
Institution of British Agricultural Engineers, 6 Buckingham Gate, London, S.W.1. (TATe Gallery 8589.)
Institution of Civil Engineers, Great George Street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. (TEMple Bar 76767.)
Institution of Engineering Designers, 38 Portland Place, London, W.1. (LANgham 8847.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, S.W.1. (SLOane 3158.)
Institution of Locomotive Engineers, 28 Victoria Street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland Place, London, W.1. (LANgham 3802.)
Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield Street, London, W.1. (GROsvenor 5254.)
Institution of Public Health Engineers, 118 Victoria Street, London, S.W.1. (VICtoria 3017.)
Institution of Railway Signal Engineers. Apply to Mr. R. L. Weedon, 222 Marylebone Road, London, N.W.1. (AMBassador 7711.)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W.8. (BAYswater 9101.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1. (VICtoria 0786.)
Leeds Metallurgical Society. Apply to Dr. P. Feltham, The University, Leeds.
Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool 2. (Central 3717.)
Manchester Association of Engineers, 18 Booth Street, Manchester 2. (Central 1717.)
Newcomen Society, Science Museum, Exhibition Road, London, S.W.7. (KENsington 1793.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Society of Chemical Industry, 14 Belgrave Square, London, S.W.1. (BELgravia 3681.)
Society of Instrument Technology, 20 Queen Anne Street, London, W.1. (LANgham 4251.)

Marketing

Financing Brazilian Buying

The activities of the World Bank—the International Bank of Reconstruction and Development—and the International Finance Corporation are steadily increasing and have now become well established instruments of economic advance for underdeveloped countries. Recent announcements of loans and specific projects affect the electricity supply and the cement industries in Brazil.

The World Bank have approved a loan equivalent to $73 million for the first stage of the largest hydroelectric project ever undertaken in Latin America. The completed project will bring an increase equal to 50 per cent of the power capacity now available in central-southern Brazil, the area in which four-fifths of Brazil's industry and much of the agricultural activity is concentrated. The loan is, with the exception of that made two years ago for the Kariba dam in Rhodesia, the largest the Bank has ever made for a single project. It is the first in which private companies have joined official Brazilian agencies to carry out a large power development. Central Eletrica de Furnas, SA, who will construct, own and operate the new plant, was formed a year ago as a joint enterprise between official bodies—the Brazilian Government, the State of Sao Paulo and CEMIG (a corporation owned by the State of Minas Gerais) who together hold the common stock representing 50 per cent of the equity. The greater part of the preferred stock is held by private companies—51 per cent by Sao Paulo Light Company, an affiliate of Brazilian Traction, and 9 per cent by Companhia Paulista de Forca e Luz, an affiliate of the American and Foreign Power Company. The power station, to be built at Furnas Rapids on the Rio Grande, will ultimately have a capacity of 1,100 MW. Three other hydro-electric stations, one of them Bank-financed, are already in operation on the Rio Grande.

The IFC are also operating in Brazil. They agreed last month to invest a total of $1·2 million in Companhia Mineira de Cimento Portland SA (COMINCI). The company will construct and operate a new cement plant at Matosinhos, Minas Gerais, with a capacity of approximately 200,000 metric tons per annum.

The company was formed several years ago by private Brazilian investors who contributed some valuable limestone deposits. The president is General Orlando Moreira Torres. Mr. Adolf Marcus, an Israeli citizen residing in Brazil and France, later provided substantial finance and acquired a controlling interest. More recently they have secured the benefit of engineering and management agreements with the well known cement company Lafarge of France, who propose also to make an investment in the share capital. Christiani-Nielsen, a Brazilian contracting firm, have already commenced construction of the plant under the supervision of Lafarge. The cement-making machinery and equipment are being supplied by Compagnie Fives-Lille-Cail of France. Production is planned to commence by the end of 1959 with a labour force of about 130. Upon completion of the new plant, COMINCI will be in a position to make a substantial contribution to the supply of cement in the area of the fast-growing city of Belo Horizonte.

Flying Cars to Customers

Something new in car transport was started recently by Vauxhall Motors. Starting in mid-December, Victor, Velox and Cresta cars will be flown from Luton to Belfast, at the initial rate of one trip per weekday. The Bristol Freighter aircraft to be used will carry either three Victor or two of the larger models, plus approximately 4,000 lb of spare parts and one passenger. The airline operating the service is BKS Air Transport Limited, who will use return flights for contract cargo from Belfast to Southend.

Vauxhall say that air delivery of new cars has a number of advantages over sea transport that should make it worthwhile. The first is speed of delivery—especially valuable at peak selling times, or when stocks of any particular model in Northern Ireland are low. Second is the fact that cars will reach customers in Northern Ireland in better condition. They will have covered very small road mileage; they will be cleaner; they will be less likely to be scratched or marked. In addition, the new service will provide "emergency" speed for routine spare-parts deliveries. The cost compares favourably with that of transport by land and sea.

Technical Advertising

Some expert guidance on the advertising of engineering products is given in a new book entitled *The Technical Advertising Agency—What it is, What it Offers.* The publishers are J. Peers and Associates, who are one of the very few advertising firms who specialise in the handling of engineering accounts. Their little book indicates why they call themselves "a technical service agency," which is described in the introduction as "an integrated organisation composed of highly specialised experience and skills in every aspect of marketing and sales promotion." The agency set out to provide guidance on publicity for engineering products which requires an ability to grasp technical meanings and to gauge the reactions of engineers, in design, purchasing or plant maintenance. In this J. Peers would seem to be exceptional.

Change in Retailing

The changing face of retailing will be discussed by delegates from all sections of the retail trade at the 1959 Retail Management Conference of the British Institute of Management which is being held at the Majestic Hotel, Harrogate, from 10 to 12 March. The theme of the conference, "The Next Ten Years in Retailing," will provide ample scope for resolving the vital issues likely to arise during that time. The conference will consider "those changes retail management should be making, or at least considering, today in order to survive and succeed tomorrow."

One of the positive ways open to private retailers, for example, in their fight against increasing competition and labour costs, is by banding together in "voluntary chains." How this has been done successfully will be described by a speaker from the continent of Europe. How to reduce labour costs will also be examined—the use of part-time workers and the introduction of automatic methods are two of the ideas put forward. Another paper will consider the physical layout of shops and a session will be set aside for films on retailing and other forms of selling.

Egyptian Re-Opening

The placing of an order worth £250,000 with Ruston and Hornsby by the Egyptian Government suggests that the damaging effect of the Suez dispute may be wearing off. It also indicates that the dependance on the Soviet Union for capital goods and technical services is not all-inclusive. Yet it could mislead. The Egyptian market, as we knew it in pre-crisis days, with its cotton-based economy tied to this country, is unlikely ever to return.

In assessing the significance of this large order for diesel engines and pumps, the rather special position of Ruston in the Middle East should be taken into account. No other firm, British or foreign, have roots quite so deep as Ruston's have in the irrigation and agricultural markets of that area. At the same time, it would be quite wrong to assume nothing can be done. Egypt's needs are greater than ever and the memories of British products recent enough to enable her industrialists to retain a critical faculty when examining the products of Soviet Bloc countries. The greatest need, perhaps—other than a competitive price—is for tact and persistance.

Boom in Appliances

Figures released by the Electricity Council of sales of new domestic appliances by area electricity boards show for the first time the tremendous impact which the relaxation of credit restrictions has had on demand. During October sales of refrigerators were up by over 68 per cent above the corresponding period in 1957, more than twice the average increase during the twelve months ended 31 October. A similar pattern was evident throughout. Sales of washing machines were up by 34 per cent in October, compared with 8 per cent for the 12 months; those of cookers by 51 per cent (6 per cent) and of immersion heaters by 35 per cent (15 per cent).

The full impact of booming demand has yet to be felt by manufacturers, since there was a large stock buffer to absorb. When this has gone the industries concerned are likely to experience their busiest time ever.

Toujour Le Service

The growing multitude of motorists who will elbow their way forward on our new (and old) highways is providing a vast potential market for those who repair what they break. Already the manufacturers of motor cars offer almost anything as a works reconditioned part, from an engine or gearbox to back axle or radiator. There is a price for a new component and a price for a reconditioned one, the difference usually being substantial.

This kind of service is gradually extending to other components and equipment. A recent announcement by Richard C. Gibbins, of Birmingham, indicates that they are providing an off-the-shelf replacement service for their range of general-purpose jacks, the only charge to the customer being the repair cost of the damaged equipment sent in exchange.

In cases when the manufacturer is either unwilling or unable to supply works reconditioned components, firms are springing up to meet the demand. Parts reconditioning, with plenty of competiton and therefore the hope of realistic prices, may go far to cheapen the average motorist's repair bill.

Production

STAINLESS STEEL
Made in Birmingham

BIRMINGHAM has long been noted for the number and diversity of its industries, but until recently the city included little or no steel among its products, in spite of there being a large local market for steels of all kinds. The recent commissioning of new plant, however, by Spartan Steel and Alloys Limited, St. Stephens Street, Birmingham, 6, has set the seal on a new venture—the manufacture of stainless steel—and yet another Birmingham trade is firmly established.

First tried nearly three years ago in a 10 cwt high-frequency electric furnace belonging to a company associated with Spartan Steel, the production of stainless steel ingots suitable for subsequent forging or rolling was so successful that plant extensions were soon needed. A 15 cwt Birlec high-frequency furnace was therefore brought into use, and steel production was raised from 60 to 260 tons a month. This equipment in turn was soon found to be inadequate for the demand and was augmented. In 1957 a 3 ton nominal capacity Birlec arc furnace was ordered and building of a new melting shop was started. At the same time, Spartan Steel and Alloys Limited was formed to run the growing business.

A new shop, 182 ft by 48 ft, has been built to house the new arc furnace and other equipment, and the existing high-frequency furnaces. Special attention has been paid to the allied problems of lighting and ventilation in the new shop, which is lofty and well provided with glazing. The upper part of the roof is equipped with adjustable louvres. A specially designed fume hood, made by Tilghman's Patent Sand Blast Company Limited, is very effective in drawing the fumes from the furnace. Two overhead electric travelling cranes by John Smith (Keighley) Limited, one of 5 tons and the other of 10 tons capacity, serve the whole shop floor.

Two 15 cwt Birlec high-frequency furnaces, hydraulically tilted, are installed as well as the new arc furnace. The latter, of 3 tons nominal capacity, is of normal design, just over 7 ft diameter, and of 1,500 kVA rating. As is usual with furnaces of this type, the roof is lifted clear of the shell for charging, which is done by a bucket from the overhead crane. The furnace is equipped for oxygen lancing, oxygen being supplied from an adjacent liquid oxygen plant.

A scrap yard adjoins the melting shop, the handling equipment including a K & L 6 tons mobile crane, with a grab and an electromagnet, a steel turnings crusher, a Fielding and Platt baling press and scrap cutting equipment. Swing grinders are installed for ingot surface dressing, and there is a fully-equipped laboratory which exercises chemical and metallurgical control over the steelmaking.

All ingots cast in the Spartan works are teemed by the conventional top pouring method, and exothermic feeding heads are used on the ingot moulds to ensure that the ingots shall be sound and free from piping defects.

Stainless steel ingots are cast by Spartan at present in sizes varying from 20 lb to 3½ tons, and from 3½ in to 24 in square. Martensitic, ferritic and austenitic steels are cast, as well as heat resisting qualities. Martensitic and austenitic steels are also made in the so-called "free-cutting" qualities. British and American standard and other specifications can be met, and the company's steelmaking, chemical and physical testing arrangements are AID approved.

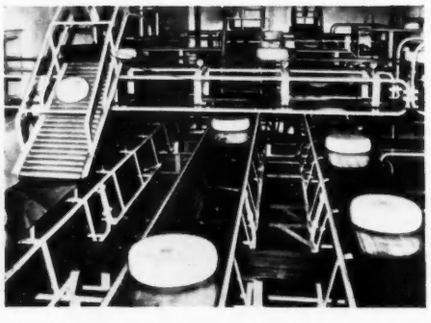
Spartan Steel are producing, for the first time in Birmingham, some of the stainless steels which find such a large application locally.

There are no facilities for steel rolling at Spartan works, but arrangements have been made by the company for their ingots to be rolled elsewhere, and they keep large stocks of rounds, squares, hexagons and flats, as well as ingots in numerous sizes and in black, descaled, bright and, where applicable, centreless ground finish.

Research is actively proceeding on centrifugal casting of billets and bars, and investigations are being carried out on methods of improving ingot structure by adding "rare" metals to the melt.

BULK CHEESE HANDLING

Faced with the problem of efficient handling of Gouda cheese in quantities which had outgrown the available equipment, De Producent, the co-operative distributing organisation at Gouda, Holland, decided to build a new warehouse. The average quantity of cheese handled weekly is 350 tons, and the building was required to have a storage capacity of 4 million pounds and to serve as a transit warehouse, as the cheese has a maturing time of 5 to 7 weeks. Other design requirements were that the handling should be kept to a minimum, that what handling there was should be fast, and that the handling methods should be hygienic. Delivery of cheese takes place in a period of 4 to 5 hours daily, and the handling system had to deal with these arrivals without causing undue waiting by the lorries.



Gouda cheeses move at 90 ft/min in the new warehouse of De Producent, Holland.

All these considerations pointed to a single-storey building with belt conveyors and a one-way traffic system for the product, and this was the design adopted. The building is 315 ft by 200 ft, and the actual storage area is a series of double racks running along the building length and covering an area of 200 ft by 160 ft.

Deliveries are made by lorries each carrying about 15 tons of cheese, and the vehicles are driven straight on to one of three weighbridges. Cheeses are then unloaded by hand to a conveyor system for transport to storage. There are 25 conveyors in all, with a total conveying length of 4,500 ft, serving the storage racks which have a total shelf length of 43 miles. All the conveyors, which are of the steel belt type, with belts 18 in by 0·032 in, and run at 90 ft/min, were supplied by Sandvik Steel NV, Rotterdam, an associate of Sandvikens Jernverks Aktiebolag, Sweden.

Three short lengths of conveyor take the cheeses from the lorries and raise them to three more conveyors running at right angles to the first set, and extending across the width of the building. Travelling ploughs enable any one of the second set of conveyors to be fed from any one of the first. At right angles to the second set of conveyors is a further set, 14 in number, which extend down the length of the building in between each pair of double racks, at a height of about 8 ft from the floor. Ploughs enable these conveyors to be fed at will from the cross conveyors.

HAND STACKING

From the 14 lengthwise conveyors the cheeses are ploughed on to carriages running down each passageway, and here they are raised or lowered as required, by a short length of rubber belt conveyor, to the stacking position. They are then lifted off by hand and placed in the storage racks. Only two men are required to deal with the complete lorry load; one man unloads the lorry and the other stands on the discharge mechanism and places the cheeses in the racks. All three sets of conveyors can be controlled from a central point near the weighbridges.

To take cheese out of storage the small carriage between the racks is loaded by hand and the cheeses travel to the opposite end of the building from the loading point. Here they are ploughed off to any one of three cross conveyors and pass finally by a further conveyor, again at right angles, to a wrapping section which runs parallel with the storage racks.

Like the loading conveyors, those for discharging the racks can be controlled from a central point. There is telephone communication between the two points, and efficient control has enabled the system to work in either direction at 45 tons/hr.

Metals and Materials

FLAME-PLATING IMPROVES ALUMINIUM PULLEYS *for Wiredrawing*

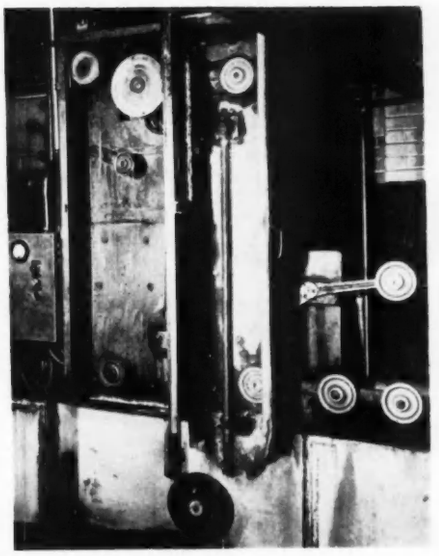
A leading American cable company has saved over $1,500 per year on a wiredrawing machine by having its aluminium alloy pulleys flame-plated to increase their wear resistance.

The flame-plating process is a surfacing operation in which particles of tungsten carbide are blasted on to the surface of the workpiece. This is done with a specially constructed gun in which particles of tungsten carbide are fed into the chamber of the gun and are suspended in a mixture of oxygen and acetylene. When the mixture is ignited, a detonation wave carries the particles through the barrel at supersonic speed. The particles, which are hot and plastic when they leave the barrel, embed themselves in the surface of the workpiece, where microscopic welding action produces a tenacious bond. Although temperatures in the barrel reach 6,000° F, the part being plated seldom exceeds 400° F. Thus, the part retains its metallurgical properties. Successive applications build up the coating material to the desired thickness.

The company operates a wire drawing machine 24 hours a day, five days a week, to draw copper wire to about 0·020 in in diameter. The machine has seven 5 in diameter aluminium pulleys, used in the annealing cabinet and on the tension arm, which operate at from zero to 5,000 r.p.m. Some of the pulleys are subjected to a waterspray bath. Aluminium was chosen for the pulleys because of its corrosion resistance and because the low moment of inertia reduces wire breakage during starts and stops.

Standard unplated aluminium pulleys (plus necessary bearings) each cost $10, and the total cost of the pulleys per machine was $70. Unplated, the pulleys had a life of 10 working days, so that the running cost for the pulleys per machine was about $7 per day. The flame-plated pulleys and bearings cost about $22 each, or $154 per machine, and service life was increased to 220 days, so that pulley costs were reduced to $0·70 per day, a saving of $6·30 per day, or about $1,650 per year per machine. This, of course, was the savings on pulleys alone; other substantial savings resulted from a drastic reduction in maintenance labour and virtual elimination of loss of product which occurred formerly due to time lost during change-over and faulty operation of the machine before worn pulleys were replaced.

Additional information may be obtained by contacting the Linde Department, Union Carbide International Company, 30 East 42nd Street, New York 17, N.Y., USA.



" Flame-plating " the seven pulleys of the copper wiredrawing machine increased their life from 10 to 220 days.

STANDARD PRESSURE VESSELS

Industry's comments on and criticisms of the provisional (1949) edition of B.S. 1500 have been taken into account in preparing the first part of a British Standard for fusion-welded pressure vessels for use in the chemical, petroleum and allied industries. This first part deals with pressure vessels in carbon and low alloy steel.

It has been said that British manufacturers were handicapped in the export trade because the safety factors imposed by the provisional standard were too high. BSI say that they are very alive to the need to lower factors of safety and are taking steps to obtain data without which they do not feel sufficiently confident to introduce such new factors.

Pointing out that the petroleum industry makes very wide use of pressure vessels, the foreword to the publication states, " . . . full consideration has been given not only to British practice, but also to the experience of the American petroleum industry." And again, " . . . the design of pressure vessels, particularly in the chemical industry, is the subject of continuous development, and it is intended to keep the standard under review in order to incorporate such modifications as are found desirable as a result of progress."

The vessels fall into one or other of three classes, the class being dependent on the products' adherence to requirements of varying stringency under the headings: design, materials, control of quality, and weld joint factor. The illustrated standard covers eighteen aspects of pressure vessels as diverse as manholes and protective devices. Entirely new in this edition are the appendices on a tentative recommended practice for vessels required to operate at low temperatures, and on examples illustrating the application of the formulae and rules which are to be found in the standard.

Copies of this " bumper " publication of 133 pages may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. (40*s*).

FUSED SILICA *replaces* NATURAL QUARTZ

Owing to its extremely high purity, fused silica has considerably better transmitting properties in the ultraviolet region of the spectrum than natural quartz, and for this reason Unicam Instruments Limited, Cambridge have recently replaced the quartz prism in their SP.500 ultraviolet spectrophotometer with a prism of this new material. The result has been to extend the useful range of the instrument from 200 μ to the region of atmospheric absorption at 186 μ and greatly to improve its performance in the important 200-250 μ range.

Quartz in its natural state is a material which, however carefully selected, is subject to trace impurities, and which, owing to its crystalline structure, presents limitations to cutting. Synthetic silica, on the other hand, whilst being chemically identical with pure natural quartz can be manufactured under strictly controlled conditions so that virtually no impurities are introduced, and being amorphous, may be cut without difficulty in any orientation.

STUDDED SPOT WELDS

A promising development in resistance welding, which has been provisionally patented, has been made by the British Welding Research Association, Abington, in the course of work it was doing for the United Kingdom Atomic Energy Authority.

In spot welding, molten metal is expelled if the welding current is too high or if the electrode force is too low. It has been found, however, that this molten metal can be directed into a cavity in the welding face of an otherwise normal spot welding electrode where it freezes to form a stud, which is firmly welded to the parent sheet. This technique is known as resistance casting and sometimes as stud raising, or pimple welding.

Studs of widely varied shapes and sizes have been formed by the process over a large range of metals, including steel, stainless steel, light alloys, titanium, and nickel alloys. If required, a peg of similar or different material, previously inserted in the electrode cavity, can also be cast into the stud. With compatible metals a strong metallic bond between the peg and stud can be formed, although with non-metallic pegs, the purely mechanical joints thus formed may also be strong. If both electrodes are provided with a cavity, projections will be formed on both sides of the article. Since the metal for the stud is drawn from the molten spot weld nugget it is generally necessary to have at least two sheets of metal between the spot welding electrodes in order to raise a stud.

It is proposed to undertake a survey of possible industrial applications for the new process. For example, this technique may be used to raise projections on tubes or flat surfaces to form heat exchangers, or on the surface of thick metal for projection welding, in cases where pressing would be impossible.

MISCELLANEOUS PLASTICS TESTS

Even in the most well contrived filing system there is a place for the " miscellaneous," which in providing a home for all the loose ends and misfits may often swell to vast ranks. Surprisingly, therefore, Part 5 of British Standard for Methods of Testing Plastics, subtitled " Miscellaneous Methods," is of a size comparable with the previous four parts. These, to refresh the memory, catered for tests for finding the effect of temperature on the properties, for determining electrical and mechanical properties, and for analysis. Tests in Part 5 of BS2782:1958 which did not fit into such sub-divisions cover such properties as apparent density and bulk factor, absorption of water, and resistance to chemicals, light, flames and colour bleeding. A complete covering of the test methods using correct nomenclature may as usual be found in a copy of the standard, obtainable from the Institution, Sales Branch, 2 Park Street, London, W.1. (10s)

Book Reviews

HEAT AND HEAT ENGINES

Einführung in die Technische Thermodynamik (Introduction to Technical Thermodynamics). By ERNST SCHMIDT. 7th improved edition. Berlin 1958. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* (528 pages, name and subject index, 30 *DM.*)

Dr.-Ing. E. Schmidt is a professor at Munich Technical University. The revised edition of his book includes the thermodynamics of the more recent heat engines such as gas turbines, rockets and ramjets, and is also intended as an introduction to the elements of chemical thermodynamics, thus widening the horizon of students. Unfortunately, in this new edition, the author has adopted the unfortunate " International MKSA (or Giorgi) System " of units. In this, the kilogram forms the unit of mass; this may confuse the reader who takes the kilogram as the unit of weight and force. The author introduces a variety of freshly coined Giorgi names for standard thermodynamic concepts, such as the " Newton " (or the force which imparts to 1 kg mass the acceleration of 1 m per sec), the " kilopond " (or 1 kg of weight or force), " kilopondmetres," " Torr " (or unit of atmospheric pressure) and, perhaps the better-known, " Bar " (a unit of pressure).

Apart from this criticism (which generally applies to most of the new and excellent engineering books now published in Federal Germany), this textbook is well and comprehensively written, covering modern developments and discussing present problems in a clear manner. The author also thoroughly covers the fundamentals of his subject.

The discussion of knocking in internal combustion engines (one page) may need revision in the light of more recent experimental research. One chapter deals with the flow of gases and vapours, other sections with the mechanics of rocket flight, the possibilities of space travel, and jet propulsion in general. The scope of the book is thus not kept within narrow limits. Heat transfer is treated fully as is thermochemical stability during exothermal reactions, and also their reversibility. Appendices contain fully reasoned solutions of problems; steam tables and Mollier diagrams are also included.

Thermische Turbomaschinen Erster Band: Thermodynamisch-Strömungs-Technische Berechnung (Thermal Turbines Vol. 1, Thermodynamic-Fluid-dynamic Calculation). By WALTER TRAUPEL. Berlin 1958. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* (407 pages with figures, name and subject index; attached are entropy graphs of combustion gases. 58·50 *DM.*)

The present volume, by Dr. W. Traupel, who is a professor at Zürich Technical University, is the first of two which deal comprehensively with the elements and design procedure for steam and gas turbines and turbocompressors. The work is written for advanced engineering students and for practical designers. Dr. Traupel, too has fallen for the MKSA-Giorgi dimensional system of engineering units which inflicts the kilogram as unit of mass upon the designer. For the unsuspecting man in the design office the book would, therefore, lose in value as a source of quick reference. The author does, however, state nearly everywhere in brackets the equivalent dimensions in more familiar systems of units.

The initial chapters contain the elements of thermodynamics and heat cycles of engines. This is followed by 60 pages of clearly and concisely written fluid-flow theory. Questionable, however, is the wisdom of introducing a hypothetical concept (expansion shock) just in order to say that this is incompatible with the laws of thermodynamics. Rightly emphasised is the growing importance of boundary-layer theory for the interpretation of experimentation with turbines, and as a tool for flow calculation in such machines. Following this more general introduction are chapters dealing with elementary-step theory, with the flow through blade cascades, with three-dimensional flows in turbines, with the empirical acquisition of data for turbine layout, with arrangements of multi-stage turbines and compressors, with sealing problems, thrust compensation, and the behaviour of turbo-machines when operational conditions are varied. There are ample references to literature. But while American research reports are often quoted, very little reference is made to work done in this country.

A. R. WEYL

LIKEWISE FOR ENGINEERS

Matrix Theory for Physicists. By J. HEADING. *Longmans, Green and Company Limited, 6 and 7 Clifford Street, London, W.1.* (35*s*)

Despite the author's opinion expressed in his preface to this first edition, that engineers could profitably study the first two chapters though the applications that follow have little in common with engineering requirements, the title might well have been " Matrix Theory for Engineers and Physicists." Moreover, what may be physics now can very quickly become engineering and the days have gone when an engineer's mathematical ceiling was generally low.

The first chapter begins with a fundamental definition of a matrix and then describes the basic operations of matrix algebra. Some useful notes on determinants are also included. Two sections are worthy of particular mention, the first dealing with matrix representation of a vector product and the second defining first and second order Cartesian tensors. The increasing use of the digital computer in solving complex eigenvalue problems makes the second chapter, on the subject of characteristic roots and vectors, especially valuable to vibration engineers. Initial definitions are followed by an investigation of the properties of roots and vectors. Reduction of matrices to diagonal form and applications to quadratic forms are also considered.

The remainder of the text is concerned with applications. While it is true to say that the chapter dealing with geometry is not of general interest, the following chapter on applications to mechanics is invaluable to the mechanical engineer working in this field. The fundamentals of mechanics are presented in matrix notation leading up to a matrix representation of the equations of motion of Hamilton and Lagrange. The applications to electromagnetic theory will be of direct interest to electrical engineers, although to benefit from this section a knowledge of vector analysis is required. In dealing with the special theory of relativity the author assumes the reader's familiarity with the physical background to the theory and the experiments upon which it is based.

The Lorentz transformation is presented in matrix notation in both a simple and more general form, and sections are included dealing with relativistic kinematics, dynamics and electromagnetic theory. In the final chapter applications to quantum mechanics are considered. Matrices are introduced into the theory and methods of matrix mechanics are employed to the problem of the harmonic oscillator and angular momentum. The book ends, appropriately, with a section devoted to the relativistically invariant equation of the electron.

The work although concise, is clearly written and adequately indexed. Examples are provided, where necessary, both in the text and at the ends of the individual chapters. It forms a useful introduction to matrix theory for engineers, research workers and scientists requiring a basic knowledge of the subject. Further reading of both an elementary and advanced nature is catered for by a list of well chosen references given in the bibliography.

W. CARNEGIE

The Reviewers

Mr. A. R. Weyl, A.F.R.Ae.S., A.F.I.A.S., F.B.I.S., is a consultant in aeronautical engineering.

Dr. W. Carnegie, B.Sc., A.M.I.Mech.E., is a lecturer in mechanical engineering at the University of Birmingham.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Engines and Pumps

J-Range Diesels. MIRRLEES, BICKERTON AND DAY LTD., Hazel Grove, Stockport. The J-range of industrial diesel engines includes in-line and V types, normally aspirated and turbo-charged, covering powers from 141 to 2,272 b.h.p. at speeds up to 900 r.p.m. Brochure gives details.

Automotive Diesel. NORRIS, HENTY AND GARDNERS LTD., Barton Hall Engine Works, Patricroft, Nr. Manchester. The 6LX engine is designed for automotive applications and develops 150 b.h.p. at 1,700 r.p.m. Minimum fuel consumption 0·330 lb per b.h.p./hr. Description and performance curves in booklet No. 558.

Variable Speed Gears. CARTER GEARS LTD., Thornbury Road, Bradford, 3. Hydraulic variable speed gears with single lever control; three sizes. Leaflets DFC 1 and 2 give details.

Engines in Use. COVENTRY VICTOR MOTOR CO. LTD., Coventry. Folder illustrating some of the applications of the Coventry Victor engines over the world.

Reduction Gears. LINK-BELT CO., Prudential Plaza, Chicago 1, Illinois, USA. In-line shaft-mounted speed reducers, single and double reduction with ratios up to 15 to 1 and powers up to 50 h.p. Full range is described in booklet No. 2618.

Turbocharger. SIMMS MOTOR UNITS LTD., East Finchley, London, N.2. The Simms Eberspacher turbo-charger is described in detail in a booklet, together with performance curves, and notes on matching and operating.

Engine Indicator. STANDARD TELEPHONES AND CABLES LTD, (Transmission Div.), North Woolwich, London, E.16. The Standard Sunbury indicator shows engine performance on a cathode ray tube with photographic attachments. Pressures, etc., are detected by electromagnetic pickups, and the time base is given by a mechanically driven trigger unit. Booklet C/IT-11.

IN SITU CRIB

Guide to Concrete Road Construction: Questions and Answers. Second Edition. Compiled by the Staff of the Road Research Laboratory, DSIR, and Cement and Concrete Association. *Issued by the Association from 52 Grosvenor Gardens, London, S.W.1.* (*Available free of charge on request.*)

At the southern end of the London to Birmingham motorway is the St. Albans bypass. It is an " all-concrete " road, including the running surface, and those concerned with its construction believe it to be a very good road—particularly in respect of riding qualities. The fact that publicity has been sought for this particular excellence of the new bypass is some measure of the shortcomings of earlier concrete roads. Runways and airstrips have been successful but somehow concrete roads have never been quite so good as was expected: joints have been uneven, local cracking has often been bad, and frequently surface irregularities have given drivers and passengers alike an uncomfortable journey.

New roads, and better roads, however, are wanted badly—both in Great Britain and overseas. Nowhere is there a sufficiency of good roads. In Britain, there is a real demand for better roads —a demand that is being reflected by a not inconsiderable expenditure, whatever certain campaigning bodies may say to the contrary. Certainly the roads—and road haulage—are getting a much bigger cut at available funds than the railways (and the canals are very poor relations indeed). Over the last ten years, and not forgetting the initiation of the Railways' Modernisation Plan, the expenditure on road construction and improvement has been three times the corresponding figure for railway track. Brigadier Lloyd may not have succeeded in converting any existing railways into roads, but he has surely made certain that the railways get no more than is essential to their requirements; thus, misunderstood, he has freed money for the roads.

Just what is the best material to use in constructing a road is perhaps the one relevant question not amply discussed in the new booklet *Guide to Concrete Road Construction*. This little guide has been prepared by the joint efforts of staff from the Road Research Laboratory of DSIR and the Cement and Concrete Association, and somewhat understandably the case for concrete is made and accepted in a few lines. But if the highway engineer wants a concrete road he can resolve most of the difficulties that might arise by turning to this booklet—or the comprehensive references that are quoted in footnotes.

It is intended primarily as a guide for highway engineers, not a textbook. Arranged in question and answer form, it sets out to be a useful source of information for all concerned in building concrete roads. The eighteen sections into which the matter is divided range from requirements of the subgrade and preparation of the base to mixing and placing concrete, the provision of drainage and kerbs, and some observations on maintenance and repairs. Quality control and the selection of plant are among the other points discussed, with brief (though adequate) reference to hardening accelerators, air-entraining agents and wetting agents. Design—the selection of slab thickness and extent, the need and disposition of reinforcement or the possible use of prestressing techniques—is also treated in this admirable little booklet. The display of the text is straightforward, for the compilers have completely avoided the use of either line drawings or half-tone illustrations; the language is terse as well befits the question-and-answer arrangement. Little, if any, previous knowledge on the user's part is presumed, yet full cognisance is given to American and continental experience as well as to the lessons learnt at the Laboratory or the Association's Wexham Springs laboratory.

The first edition of this booklet—under the title of *Questions and Answers on Concrete Road Construction*—was first published in June, 1949. Little enough road construction came about in the years that followed. But if hard experience was not forthcoming, a sound body of knowledge was being compiled by the Laboratory and the Association. Both bodies—especially the CCA —have organised exhibitions and special lectures, and conducted courses for all grades of staff from senior engineers, through assistants to foremen and gangers. Thus a good grounding in concrete road technology has been placed among contractors and municipal engineering offices. The new booklet will make an excellent crib now that that technology is required *in situ*.

NEW BOOKS

A Textbook of Fluid Mechanics for Engineering Students. By J. R. D. FRANCIS. *Edward Arnold Limited, 41 Maddox Street, London, W.1.* (24*s*)

The author is a Lecturer at Imperial College and his book is aimed at the first two years of the engineering degree course or HNC. Problems are given at the end of each chapter and a short " Further Reading List " at the end of the book.

Engineering Drawing, and Drawing Office Practice. By P. S. HOUGHTON. Second Edition Revised. *Crosby, Lockwood and Son Limited, 26 Old Brompton Road, London, S.W.7.* (20*s*)

The first edition of this book appeared in 1950. The second edition has retained the layout, with minor corrections, but of course the recommendations of BS 308 : 1953 have been taken into account.

Telecommunications. By A. T. STARR. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, W.C.2.* (37*s* 6*d*)

Intended to cover the syllabus for the subject at the University of London. Other students should find the book useful. A second edition, it includes examples from the more recent papers.

Axial Flow Compressors. By J. H. HORLOCK. *Butterworths Scientific Publications, 4 and 5 Bell Yard, London, W.C.2.* (40*s*)

The little book literature that exists in English on this specialist subject has here a useful addition. 189 references provide opportunity for enthusiasts to indulge in more detailed study.

Electricity Undertakings of the World. The Electrical Journal Red Book 1958-59. *Benn Brothers Limited, 154 Fleet Street, London, E.C.4.* (30*s*)

The 68th edition, this covers the past year's reorganisation of the industry. Changes in foreign undertakings are also covered, involving enlargement of this section. For instance, there are 26 new entries for Venezuela and additions for Sierra Leone, Ghana, Alaska, etc.

Space Flight. By CARSBIE C. ADAMS. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, N.Y., USA.* (86·25); and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, E.C.4.* (50*s* 6*d*)

In the preface, Dr. Wernher von Braun says " I am certain this book will soon attain the stature of one of the few great classics on this fascinating and many-faceted subject." He should know. The status of the author and his three collaborators is certainly impressive.

The British Paper Industry 1495-1860: A Study in Industrial Growth. By D. C. COLEMAN. *Oxford University Press, Amen House, Warwick Square, London, E.C.4.* (55*s*)

The subtitle is not surprising when one thinks of, for instance, the new building in Knightsbridge. One likes to assume that a future volume will cover the giants of the present day, since the present one takes us to the end of the 19th century. Its viewpoint is largely economic.

On the Shelf

By Frank H. Smith

Unilever's prestige magazine *Progress* carries, in the Autumn number, an interesting little article for the Kappists on " Understanding the scientist: the problem of communicating ideas." Unilever fully appreciate the problems of " technical authorship " and have been running courses for members of their research staffs and each research department has its general editor of technical writing. The author of the article is B. C. Brookes—senior lecturer in the Presentation of Technical Information in the Department of Electrical Engineering at University College, London.

A neat booklet from the Highways Research Board, 2101 Constitution Avenue, Washington 25, D.C., lists the publications of that body. It is so divided that you can either find out what they have published on any given branch of road engineering or, if you are seeking a particular Bulletin, Special Report, Bibliography, Abstract and what have you, these are listed numerically in their categories.

Mr. R. C. Benge, lecturer in bibliography in the Department of Librarianship of the North-Western Polytechnic (fancy having to put that lot down under " Occupation ") has compiled a bibliographical survey for Unesco on " Technical and Vocational Education in the United Kingdom." Price 5*s* from HMSO, it is divided into four parts for England and Wales, and three each for Scotland and Northern Ireland. A glossary is appended which, while giving definitions such as " voluntary schools "; " training college "; " technical college "; " school of art " leaves out such items as public school, primary school. But perhaps these do not occur in the titles given. In the index, " engineering education " is cross-referred to " industrial education." Aeronautical training does not rate an entry at all.

On behalf of the British Society of Rheology, Pergamon are publishing *Rheology Abstracts* to succeed the 3,000 abstracts the Society has published over the past 17 years in its Bulletin. Price 40*s* per annum for the quarterly abstracts. Rheology? " The Study of deformation and flow " but papers concerned with aerodynamics, crystal physics and " plasticity " theory of the stress analysis type will not normally be included.

Two or three years ago I felt I was a small voice crying alone in the wilderness when I tried to get vehement about the mass of information that was being spewed out daily. My moan was not how to catalogue it but how to dam it. Now I see that at the International Conference of Scientific Information, Sir Linder Brown has been saying (in much better chosen language, of course) much the same thing, much amplified and with bells and trimmings. " However we improve the raw material of information there will still remain poor papers, unnecessary papers, trivial papers and repetitious papers. What are we to do with them? What is to be stored? Is it the fruit of the tree of knowledge or is it the fallen leaves?"

The Institution of Engineers, Australia, is doubling up. In 1959 their usual *Journal* will have two companions in *The Civil Engineering Transactions* and *The Electrical and Mechanical Engineering Transactions*. At first these new boys will appear half-yearly but will become quarterly as the volume of papers available increases. If it does nothing else this shows that " down under " there is no Big Three. Only a Big One.

Advance notices continue to arrive of Agard's Eight-language Aeronautical Dictionary (I wonder if it includes " recession "?), but I do not *think* it is actually available. The price is, or will be, £7. I notice that Chinese—that language that everybody suspects of being the scientific language of the future—is not among those covered. Spanish and Turkish are.

Construction

EUROPOORT *Rotterdam as the Gateway to Europe*

Rotterdam now bids fair to be the biggest port in Europe and is climbing high in world rating. Its importance dates from the opening of the New Waterway in 1884. This is a lock-free, deep-water channel linking the North Sea to the main streams of the Rhine delta. Built at a time when the heavy industries of the Ruhr were expanding, it was intended for the bulk import of iron ore and cereals, and the export of coal and manufactured goods. Since then every increase in economic activity in Rotterdam's hinterland has been followed by an expansion of the port.

The central port area, destroyed during the war, was rebuilt between 1945 and 1950. It soon became clear that the port had outgrown its old harbours and would have to start spreading westwards; the region is shown on the accompanying map. The Pernis area was the first new development. The great Royal Dutch Shell refinery, is probably the biggest in Europe. In 1952 plans for the Botlek project were put in hand. In this area a further 3,500 acres of land are now being developed as harbours and industrial sites. The new Botlek docks connect directly with the New Waterway and will be able to take ships of 45,000 tons. Among installations will be an Esso refinery and a new tank farm for Caltex. Ore-handling plant and stores are provided for the stockpiling of Labrador iron ores which can only be shipped during seven months of the year.

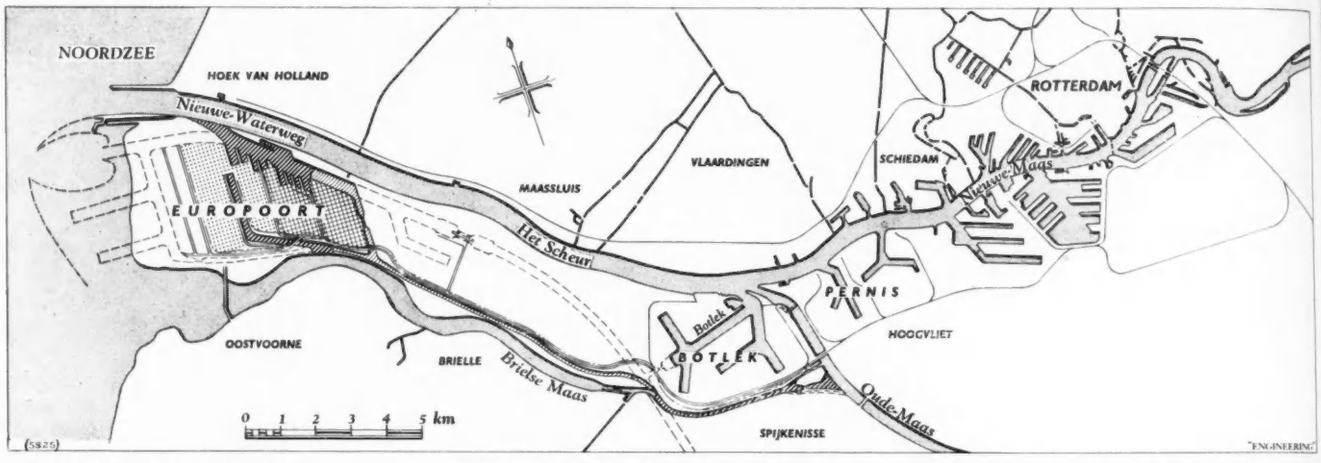
But while the excavators are still digging the new harbours at Botlek, and before the quays have been built, a new plan for further extensions and developments has been produced. This is the great Europoort Plan. "Poort" in Dutch means gateway. This new scheme is for nothing less than a gateway to Europe. This plan has not just been thought up to cater for increased trade expected to follow the opening of the European Common Market. It is the logical development of the Rotterdam dock and harbour system and is a vital part of the Dutch long-term Delta Plan. This is the scheme for linking the islands off the Dutch coast and draining the intervening channels. The waters of the Maas and Rhine will be concentrated along the line of the New Waterway and the Brielse-Maas. This part of the plan is still very much in the future. In the meantime Europoort will be built. What exactly does it involve?

The basic idea is a simple one. The Western end of the island of Rosenburg which lies between the New Waterway and the Maas, is to be developed with deep-sea docks, shipyards, coal and iron ore stores, oil storage-tanks and perhaps a steelworks. The installations will be at the point where, when work has been completed on the Brielse-Maas, inland water craft will meet sea-going vessels. The inland waterways will not connect directly with the New Waterway, but the system of docks will be such that transhipment of cargoes will be relatively easy.

The Europoort Plan deals with an area of 3,800 acres, about 1,000 acres of which will be taken up by dock basins and canals. The harbour basins will be accessible to ships of 65,000 tons. Eventually there will be a new harbour entrance direct from the sea and not via the New Waterway. When this is completed the harbours can be deepened to take even bigger ships. It is expected that ships of 85,000 tons and even 100,000 tons will be able to use the docks once the new entrance is made. One idea is that giant tankers will use these docks and that a pipe-line will be built to the Ruhr area.

Other parts of the plan are for the building of a shipyard for repairs to very big sea-going vessels. The number of European ports able to handle ships of this size, let alone repair them, will be small. The idea of building a steel works at Europoort is still very much in the air. At present there seems to be no compelling reason for increasing Holland's steel-making capacity. The Brielse-Maas which will carry craft from the inland waterways into the Europoort basins will be cut off from the sea by a dam. Eventually a new waterway parallel with the Brielse-Maas will be constructed. As it is, everything is being done to make it possible for the trains of pushed barges from the Rhine to pass right into the area without being broken up.

The cost of the Europoort scheme has been estimated at around 150 million guilders (about £15 million). This includes land costs but not that of building the quays or laying down gas, electricity and water supplies. How these big sums are to be recovered has not yet been finally decided. Commercial principles are the rule in the rest of the Rotterdam docks. The municipality provides the docks and warehouses and charges economic rents for them. This is what is likely to happen at Europoort. Construction costs are being shared between the Dutch Government, the city of Rotterdam and private investors.



The port of Rotterdam showing the areas which are at present being rebuilt or developed. Also shown is the possible location of Europoort which would further enhance Rotterdam as the gateway to industrial Europe.

BETTER BUILDING

Work at the Building Research Station

Current research on concrete, reinforced concrete, and even more so on prestressed concrete and brickwork, still tends to be mainly concerned with the fundamental properties of single elements; whereas that on structural steelwork is primarily concerned with the performance of whole structures, such as continuous multi-storey frames. Much of this work on steel structures has, however, little relevance to structures composed of other materials. These are two of the comments contained in a review issued from the Building Research Station of the work being undertaken there. As well as briefly describing the tests and drawing attention to the results, the review also lists articles and papers that have recently appeared by members of the staff. The following notes are based on the review.

So far as multi-storey steel frames are concerned, research has now shifted toward the collapse design of real three-dimensional structures. Hitherto, most work has been concerned with the elastic behaviour

of idealised two-dimensional frames. Unfortunately, the problem of the three-dimensional structure is not so easily resolved as the fully-plastic collapse design of simple portals. In multi-storey frames, the benefits arising from plasticity may be seriously curtailed by the simultaneous deterioration of elastic stability due to unfavourable changes in geometry with increasing deflections. On the other hand, composite action between the frame and the rest of the building may greatly increase the critical elastic load capacity of the building and may even allow the fully plastic load of the frame to be reached. It is at least probable that the walls of many buildings prevent (or at least reduce) sway and the much more rapid deterioration of elastic critical loads that this entails. This much, comments the review, is often tacitly assumed in design already. Some work at the Station has been particularly concerned with the stability of tall buildings and the especial relevance of composite action.

It is common practice to design the foundations of a structure as a separate entity only to provide a base that will not settle too much or, at least, will do so as uniformly as possible. Some attempts are being made at the Station to examine the possible design of buildings as a composite whole, embracing both foundation and superstructure. In this respect work has been done on small scale model groups to find the ultimate load that can be carried by a group of piles. The tests have proved self-consistent and consistent with what is known of the action of full-scale pile groups.

Among the conclusions proved are that failure might occur either by local penetration of individual piles if widely spaced or by the wholesale sinking of a group of closely spaced piles together with the soil enclosed within the group. Characteristic spacings for the change from one mode of failure to the other were found for each square group of piles of a given number and length. It has also been found that the proportion of load taken by any particular pile increased with its distance from the centre of the group.

The brick is one of the oldest building materials and its use still all too frequently follows rule-of-thumb tradition. To begin a change towards making it a modern structural material has given rise to several trains of work at the Station. In particular, an improved method of determining the crushing strength of individual bricks has been sought. Satisfactory results have been obtained by testing the bricks flatwise between plywood sheets with any frogs filled with mortar, but without the additional complication of bedding them in mortar.

Better methods of handling the bricks after manufacture have been developed and the experience summarised in a report. There has also been found a need for a new brick. For walling bricks, for instance, a better balance between strength and other properties (such as thermal insulation) seems desirable. Such matters, and the use of hollow tiles and blocks in prefabricated units, have been reviewed. The part that ready-mixed concrete can play in reducing costs on certain construction sites is discussed in yet another paper.

A better knowledge of the stiffening that brickwork can give to steel frames is being sought at the Building Research Station. Here a racking test is being made on a concrete-encased steel frame stiffened by a 3 in thick clinker-block infilling.

Two papers on prestressed concrete have dealt with prestressing steels, and a third with the design of prestressed members. Of the first two, one describes tests on beams using 12 different kinds of wire; some slightly increased load capacities have been found for some deformed wires under static loading, though their use could not be commended for repeated loading. The other gives a general survey of the properties of prestressing steels and draws attention to the desirable characteristics of such steels.

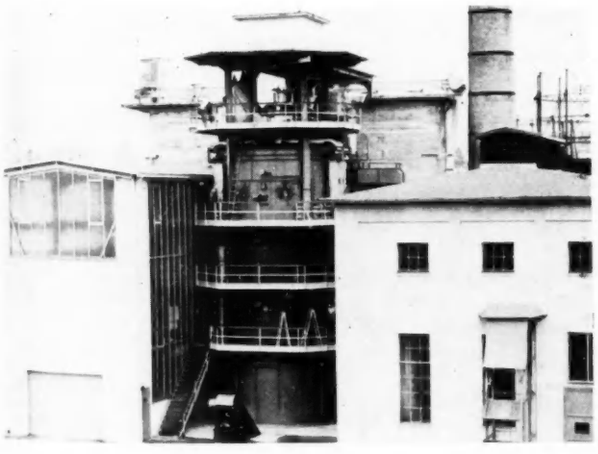
Based on some other tests, the third paper suggests that, to provide a constant load factor against cracking with either pretensioned or post-tensioned steel, the permissible bending tensile stresses should be directly proportional to the maximum pre-compression in the concrete if the calculations are based on the section modulus of the uncracked section. Other simple relationships are suggested for the calculation of ultimate flexural strengths, and the paper also discusses loss of prestress.

All the aforementioned work, and more, have been the subject of Building Research Station publications or articles in the technical Press. Details of such publications are obtainable from the Director, BRS, Garston, near Watford, Hertfordshire.

Operation and Maintenance

PULVERISED COAL FIRED AIR TURBINE RUNS 12,000 HOURS

The closed-cycle air turbine plant at Ravensburg. The machine house is on the left. The air heater, fired with pulverised coal, is on the right.



At the beginning of September, 1958, an overhaul was carried out on the first closed-cycle air turbine that is in industrial operation with pulverised coal firing. The unit concerned is the 2,000 kW turbine which Escher Wyss Limited, together with one of their licencees, Gutehoffnungshütte, Sterkrade, delivered to the works of Escher Wyss G.m.b.H. in Ravensburg.

This installation now has 12,000 hours of industrial operation to its credit. Temperature of the circuit air before the turbine is 660° C. The installation produces electric energy needed for the works, and during the winter months supplies heat for the buildings in the form of hot water.

From the last overhaul in May, 1957, until 1 September, 1958, the plant has been in continual operation and was only shut down over week-ends when no current was needed. During the coldest days of winter, the installation was also kept in service over the week-ends for the purpose of providing the heating. From 1 May, 1958, until 1 September, 1958, the plant was shut down each evening and started up again in the following morning.

Inspection of the air heater has confirmed that the tubes are in perfect condition and that the masonry has not suffered in any way despite the frequent shutting down and restarting. The burners are

Continuing

Operation and Maintenance

likewise in fully satisfactory condition. The blades of the turbine and compressor are in the same favourable state as in 1957.

In the light of the foregoing it may be said that the first closed-cycle air turbine arranged for pulverised coal firing has proved its reliability in operation.

FASTER ANALYSIS *for the* BOILER HOUSE

Development of faster methods of analysis is taking place in most fields, and steam boiler operation is no exception. The British Coal Utilisation Research Association has studied the general applications of new methods, and a paper published by the Boiler Availability Committee gives detailed, step-by-step information on the application of these methods to the analysis of coal ash, clinker, slag, boiler dusts and deposits.* Time saving by using the rapid methods is considerable, a complete analysis taking less than one-fifth of the time required for a classical analysis, and no loss of accuracy is involved.

The methods described are based on the use of two relatively inexpensive instruments which are commercially obtainable and are, in fact, standard equipment in most analytical laboratories. They are the spectrophotometer and the flame photometer. Some special organic reagents are used to produce the coloured complexes for the spectrophotometer, but they are all readily available commercially.

Two solutions are prepared for analysis, one from a fusion of the sample with sodium hydroxide for the determination of silicon and aluminium, the other from a digestion of the sample with hydrofluoric and sulphuric acids for the determination of all the other commonly occurring constituents except sulphur. The latter is determined gravimetrically on a separate sample. Colorimetric procedures are used for silicon (silicomolybdenum blue), aluminium, calcium (calcium alizarin red-S complex), iron and titanium (tiron), manganese (permanganate), and phosphorus (phospho-vanado-molybdate). A Unicam S.P.600 spectrophotometer is used for the measurement of the optical densities of all the coloured solutions. Calcium and manganese are determined by titration with the disodium salt of ethylene diamine tetra-acetic acid (EDTA) using calcein (for Ca) and screened o-cresolphthalein complexone (for Ca+Mg) as indicators. An Eel flame photometer is used for the determination of sodium and potassium.

The methods are particularly suitable for batch analysis, and five samples can be analysed in a week by one analyst with an accuracy which is better than 0·4 per cent for all constituents except Al_2O_3, for which the accuracy is, at present, about 1·0 per cent.

* Improved Methods of Analysis of Coal Ash, Slag and Boiler Deposits, by K. Archer, D. Flint and J. Jordan. Technical Paper No. 4, Boiler Availability Committee, 8 Waterloo Place, London, S.W.1.

Engineering at Home

DESIGNED GUTTER CAPACITY

Roof drainage arrangements are often more than adequate but as the results of under-provision can mean soaked footings (with an increased risk of settlement) or possibly a rotted damp course, over-generous guttering is not a fault to be too quickly condemned. Nevertheless, eaves guttering and downpipes quickly increase in price as their size increases so that the rational design of such fittings can often save expense when compared with the rule-of-thumb methods commonly adopted.

The Building Research Station has recently conducted an experimental study into the behaviour of guttering and downpipes and the findings have been summarised in a BRS *Digest* —No. 116—entitled *Roof Drainage* (HMSO, 3*d*). The flow load with which a gutter has to cope depends on the area of the roof discharging to the gutter, its pitch, the peak rate of rainfall and the angle of fall, and the duration of the rain.

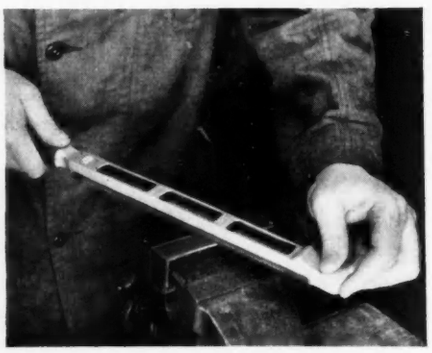
The average intensity recommended as a basis of general design of eaves guttering in Great Britain is 3 in per hour. This intensity is found to occur in any given locality for about 5 minutes every year and for a period of 10 minutes only once in about eight years. As a good and reasonable approximation it is permissible to ignore the pitch if it is less than 50° and to use the actual area of the roof as the basis for calculation; for such roofs the angle at which the rain falls can also be neglected. These approximations give the flow load in gallons per min as 0·026 × roof area in sq. ft.

The flow capacity of a simple straight gutter depends on its cross-section area, shape, length and slope. Quite a slight slope markedly increases the capacity though there is a limit to the advantage that can be achieved and too big a fall is to be avoided; a fall of 1 in in 50 ft increases the flow by about 40 per cent over the same gutter laid level; greater falls achieve little more. Length has little influence on the capacity of level gutters but may be significant for short sloping gutters.

The shape, size and position of the outlet and downpipe all affect the capacity of the guttering. Round-cornered outlets give a smoother flow than sharp-cornered ones and this has a marked effect on the flow with smaller outlet sizes. The survey showed that downpipe sizes commonly used are frequently unnecessarily large. But if smaller downpipes are used, they may run full during heavy rain—there is no harm in this—but joints should be sealed to avoid leakage.

Tables in the *Digest* give the capacities of level gutters of different types and reducing factors to take care of bends, slopes and outlet connections. Some notes are also included on the desirable positioning of the gutter with respect to the edge of the roof—some roof materials and forms " throw " the water further than others. Continued good performance depends on a good maintenance—both gutters and downpipes should be kept clean; care should also be taken that back-falls are prevented.

HAND SHAPER



The Stanley shaper file will cut wood, metal, or plastics.

A hand tool that will cut wood, metal, or tough rubber, has been put on the market by Stanley Works (G.B.) Limited, Rutland Road, Sheffield 3, in the form of a file or a plane; the former is shown in the illustration. The cutting blades are replaceable and the teeth extend all round the edge so that the tool will cut into corners and rebates. It is essentially a general purpose tool and will cut nails left in wood as easily as the wood itself. It is claimed that the teeth will not drag or plough even on mild steel.

The body is cast in light alloy with a compressed rubber grip moulded on to it. The shape of the toe allows many different finger grips. The blades are held in position in much the same way as in a hacksaw and there is a tensioning screw at the toe. This can be tightened by a coin. Swarf cut from the material passes through the holes behind the teeth and so does not cause clogging.

PLANNING FLATS AND HOUSES

The economical layout of flats and houses in residential development schemes is the main theme of *Flats and Houses, 1958* (HMSO, 10*s*). This handbook was the major publication of the Ministry of Housing and Local Government during last year.

For rebuilding older areas the book recommends a mixture of houses and low blocks of maisonettes with a few really high buildings. Too many high buildings are not desirable, otherwise costs rise disproportionately. Though much of the book is concerned with the disposition of whole flats and houses, details are given of the relation between size and cost of individual rooms; in particular, minimum space standards are given.

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